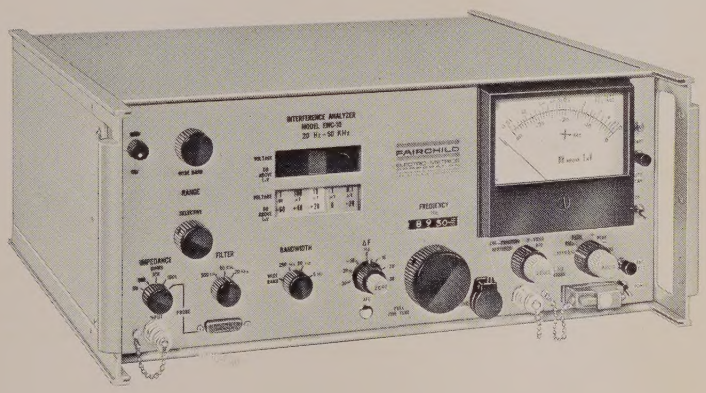
INSTRUCTION MANUAL

INTERFERENCE ANALYZER



EMC-10 SERIES

FAIRCHILD
ELECTRO-METRICS
CORPORATION
A SUBSIDIARY OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
100 CHURCH ST., AMSTERDAM, NEW YORK 12010

MP MASTER
MA30024

SPECIFICATIONS

	SELECTIVE OPERATION SETTINGS	WIDE BAND SETTINGS
FREQUENCY RANGE	20 Hz to 50 kHz	20 Hz to 500 kHz
IF FREQUENCY	100 kHz	
FREQUENCY ACCURACY	± (1/2 % + 5 Hz)	
VOLTAGE ACCURACY	± 0.5 dB, 20 Hz to 50 kHz with 500 kHz LP; to 45 kHz in 50 kHz LP.	± 0.5 dB, 20 Hz to 45 kHz with 50 kHz LP; to 450 kHz with 500 kHz LP.
IF AND SPURIOUS REJECTION	Better than 80 dB (Filter in 50 kHz position)	
INPUT IMPEDANCE (OHMS)	50, 600, 10K, 100K	50, 600, 10K, 100K
BANDWIDTH (3 dB)	5 Hz, 50 Hz, 250 Hz	20 kHz and 50 kHz, at all input impedances; 500 kHz at 10 K and 100 K ohms impedances only.

SENSITIVITY (TANGENTIAL)
500 Hz to 50 kHz - Noise at 20 Hz is 40 dB greater than chart indicates because of 1/F noise.

Impedance	5 Hz	50 Hz	250 Hz
50 ohms	.006 uV	.010 uV	.022 uV
600 ohms	.010 uV	.030 uV	.070 uV
10K ohms	.040 uV	.120 uV	.280 uV
100K ohms	.100 uV	.300 uV	.700 uV

LOW PASS FILTER POSITIONS: 20 kHz, 50 kHz, 500 kHz

METER FUNCTIONS: Carrier, RMS, Quasi-Peak, Peak (+ or -), Slideback

METER SCALE: 40 dB linear

MAX. INPUT VOLTAGE (RMS): 1 volt (10V at 10K and 100 K ohms input)

OUTPUTS (NOMINAL):

a) Restored Frequency: 1 V rms at 600 ohms.
b) IF: 1 V rms at 600 ohms
c) Tracking frequency: 1 V rms at 600 ohms.
d) BFO
e) Recorder output (1 mA at 1500 ohm DC).
f) X-Y plotting
g) Audio-video for phones or scope (100 mW with 600 ohm phones).

POWER REQUIREMENTS:

a) 105-130 or 210-260 volts AC, 50-450 Hz.
or
b) Special self-contained rechargeable battery; 8-hour use without recharging; automatic recharging provided.
or
c) External DC source, 30-38 volts.

OPERATING TEMPERATURE RANGE: 0°C to 50°C.

DIMENSIONS (APPROX.): 17-1/2"wide, 7" high, 16" deep including handles. Brackets supplied for 19" rack mounting.

WEIGHT: Approximately 32 lbs.

Specifications subject to change without notice.

Notes:
1. EMC-10E and EMC-10 with ESC-10A are Air Force approved as Category A instruments for interference testing. MIL-STD-826A procedures are available from Electro-Metrics.
2. EMC-10 with accessories is assigned FSN 6625-911-0840.

INSTRUCTION MANUAL

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REVISED NOVEMBER 15, 1968

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ADDENDUM 1

Clarifications to the specifications on the inside front cover of the EMC-10 Instruction Manual:

1) Voltage accuracy: The specification of ± 0.5 dB refers to full scale voltage accuracy. Tracking accuracy is ± 1.0 dB at cardinal points on remainder of meter.

2) While our Performance Check-out Procedure per Section III, Para. 3.15.3c.3, does not include an accuracy test for the 10 microvolt attenuator position, this test condition may also be set up and the accuracy verified in the same way. Certify at 50 ohms impedance.

3) While the Performance Check-out Procedure per EMC-10 Manual, Section III does not include an accuracy check for the 0.1 microvolt position under Para. 3.15.3c.4, this condition may also be tested for verification of the accuracy of the instrument. Certify at 50 ohms impedance.

4) Wideband Performance check: When running this test under paragraph 3.15.3.f of the Performance Check-out Procedure, Section III, EMC-10 Manual, the 10K ohm or 100K ohm input positions must be used per the requirements as indicated under Bandwidth in the specifications, which indicates that the 500 kHz low pass filter can only be used at the 10K and 100K ohm impedances. This basic requirement applies to Bandwidth Performance checking in the same way, and actually applies in all cases where the low pass filter used in 500 kHz.

5) The specification which indicates the instrument to have a 5 Hz bandwidth should be modified to indicate that this is a nominal 3 dB bandwidth.

6) Sensitivity: All the maximum sensitivities of 0.1 microvolts and below are the theoretical values based upon the definition of tangential sensitivity which we define as the amount of signal required to raise the meter reading 3 dB above the noise level. Mathematically, this turns out to be equal to the internal noise level as shown on the meter when the instrument is properly calibrated at a specific frequency. Since these are theoretical values that can't be measured due to present state-of-the-art limitations, values must relate back to the receiver attenuators and meter accuracies.

7) The 10 V position on attenuator should only be used in 10 K ohm or 100 K ohm impedance position, unless testing for transient type signals. Sustained signal levels may cause damage to the pre-amplifier.

8) Voltage Accuracy specifications on the inside front cover of the Instruction Manual should be changed as follows:

Under "Selective Operation Settings", Voltage Accuracy should read:

$\pm$0.5 dB, 20 Hz to 50 kHz with 500 kHz LP.

Under "Wide Band Settings", Voltage Accuracy should read:

$\pm$0.5 dB, 20 Hz to 50 kHz with 500 kHz LP, 50 and 600 ohm input;

1.5 dB, 20 Hz to 450 kHz for 10 K ohm and 100 K ohm inputs.

To correct the text of the EMC-10 Instruction Manual, made the following changes in the issue dated November 15, 1968:

Para. 3.12.5, P. 3-8 in 2nd column;

1. In 4th line under FILTER change 50 kHz to 500 kHz
2. Under (d) make 2nd sentence read:
   "The instrument is now calibrated for WIDEBAND usage from 20 Hz to 50 kHz in 50 ohm and 600 ohm inputs and from 20 Hz to 450 kHz in 10 K ohm and 100 K ohm inputs."
3. Under (e) make paragraph read:
   "Change bandwidth switch setting to 50 Hz or 250 Hz. If exact full scale is not obtained, the gain control should be adjusted to full scale for making measurements in any bandwidth."
4. Delete paragraph (f).

9) Page 3-13 Section 3-15.3 Performance Tests
b) Amplitude Calibration Check - Should now read

3. Change the bandwidth switch to 250 Hz and 50 Hz. The meter should read full scale within $\pm$0.5 dB.

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SECTION I
INTRODUCTION

1.1 THE MANUAL

This manual includes all relevant information for the successful operation, maintenance, and repair of all models of Interference Analyzer Model EMC-10 and 10E. It will be assumed that unless specifically noted, this discussion applies to all versions.

1.2 THE EMC-10

An increasing number of specifications and standards are defining electromagnetic compatibility in the audio range down to about 20 Hertz. Fairchild Electro-Metrics' Interference Analyzer Model EMC-10 has been designed to fill the growing need for instrumentation for RFI/EMC measurements in this range.

The range of 20 Hz - 50 kHz is typically the range covered by instruments known as "wave analyzers." Because many of the usual circuits and functions of the wave analyzer were found to be essential to a versatile RFI meter for the audio range, it was decided to design the instrument so that it could also be used as a full-fledged wave analyzer.

1.2.1 ELECTRONIC TUNING. In view of the increasing importance of speeding up the rate of RFI/EMC data acquisition, it was clear that dependence on mechanical tuning of the frequency-determining element should be avoided, if feasible. Fortunately, recent advances in solid-state circuit techniques resulted in the creation and refinement of a voltage-controlled oscillator (VCO) circuit suitable for use as the local oscillator in this application.

The circuit employed is basically an astable multivibrator whose frequency is controlled by variation of a current source inserted in the RC discharge path. The rate of discharge and the frequency are linear functions of the current; thus, by making the current vary linearly with an applied voltage, an oscillator whose frequency varies linearly in response to an applied voltage is achieved. With this arrangement, the manual tuning control becomes a voltage dividing potentiometer, and most of the usual problems associated with remote tuning vanish.

As implied by the presence of a local oscillator, the selective receiver circuitry is a superheterodyne design basically. A balanced mixer - modulator is utilized to convert the incoming signal (20 Hz to 50 kHz) up to the IF of 100 kHz. Thus, the VCO must be varied in frequency from (100 kHz + 20 Hz) to (100 kHz + 50 kHz). With the VCO circuit utilized, this frequency variation from 100.02 kHz to 150.00 kHz is accomplished by application of a DC control voltage varying from 0.0 to 1.5 volts.

As already implied, this control voltage of 0.0 to 1.5 volts can be either generated locally, using the front panel tuning control (a 10-turn potentiometer) or other built-in voltage source, or applied to the instrument from an external source. This points to two very significant advantages resulting from a voltage-tunable instrument: 1) Automatic scan can be accomplished without having to connect any mechanical linkage to the instrument and 2) A spectrum analyzer for the range 20 Hz to 50 kHz is created by using an oscilloscope to derive the 0.0 to 1.5 tuning control voltage from its sweep waveform, and by displaying the output of the EMC-10 on a CRT. Any smaller portion of the 20 Hz - 50 kHz spectrum can, of course, be swept merely by appropriately restricting the control voltage variation.

1.2.2 FRONT END SELECTIVITY. In the conventional RFI/EMC meter when using higher frequencies from approximately 14 kHz and extending into the microwave region, tunable RF preselection ahead of the first mixer is normal. However, this becomes much less practical for an instrument covering the entire audio range of 20 Hz - 20 kHz, a frequency ratio of 1,000 to one. A successful solution, employed by the EMC-10, is to utilize low-pass filters in conjunction with an operating technique that eliminates or drastically reduces the possibility of inadvertent overload or intermodulation.

There are two basic channels: the top channel (see Figure 2.1) which is completely wideband and non-selective, and the lower channel which is superhet and selective with narrow IF bandwidths of 5, 50, or 250 Hz, depending upon the setting of the front panel BANDWIDTH selector switch. The top, or wideband channel, has a response characteristic extending from 20 Hz to 500 kHz; thus it will easily pass any signal within the selective operating range (20 Hz - 50 kHz). Low-pass filters common to both the wideband and selective channels are included which can restrict the upper frequency coverage to 20 kHz

or 50 kHz, as determined by the setting of the front panel FILTER selector switch.

The appropriate operating procedure, therefore, becomes that of "taking a look" at the entire coverage spectrum of the instrument in the wideband position, with the FILTER selector set to the lowest frequency compatible with the range to be tuned selectively. The RANGE selector attenuator switch is then adjusted so that the resulting peak signal level is on-scale. This assures that sufficient attenuation is inserted ahead of the first transistor stage to prevent overloading. Although the same RF attenuation is also encountered by any smaller signals which might be measured selectively, the mechanical linkage between the WIDEBAND and SELECTIVE range switches allows the maximum possible dynamic range and selective sensitivity in the presence of larger signals; not until the largest off-frequency signal equals 1 millivolt is it necessary to restrict use of the most sensitive range (0.1 uV full-scale) to the next most sensitive range (1.0 uV full-scale).

A wide range of input impedances is provided to permit full versatility of the instrument in its primary function of an RFI/EMC meter and in its subsidiary function as a flexible wave analyzer. Input impedance can be chosen, using the front panel IMPEDANCE selector switch, to be 50, 600, 10 K or 100 K ohms. This is accomplished by using a high quality input transformer to step 50 ohms and 600 ohms up to the 10 K ohms impedance of the input attenuator. The 100K ohms impedance is achieved by using a high input impedance emitter follower which, in turn, feeds the same 10 K ohm input amplifier.

In order to obtain maximum usable sensitivity, a low-noise amplifier employing selected Fairchild Semiconductor 2N2484 is utilized. Since the noise figure of the circuit does not exceed 1 dB, the result is an equivalent input noise, at 50 ohms in the 5 Hz bandwidth position, of approximately 3.0 nanovolts.

1.2.3 IF SELECTIVITY. In the SELECTIVE operating mode, the incoming signal is amplified by 46 dB to establish the system noise figure and is then fed to a balanced modulator circuit in which it is heterodyned with the output of the VCO previously discussed. Precise balancing of the mixer assures maximum rejection of the VCO signal, and thus signals down to 10 Hz may be observed with decreased sensitivity.

The IF bandwidth of 5, 50, or 250 Hz, depending on the setting of the front panel BANDWIDTH selector switch, is determined by a two-stage crystal filter. Amplification of 50 dB at 100 kHz is inserted between the filter stages and another 50 dB follows the second filter stage.

The ratio of IF bandwidth at 60 dB down to the bandwidth at 3 dB down is held to less than 10. Rejection to all signals outside of the IF bandwidth is at least 80 dB.

1.2.4 FREQUENCY STABILITY. In order to permit effective utilization of the very narrow 5 Hz bandwidth, a high degree of frequency stability is required in both the VCO and the IF filters. The VCO exhibits a temperature stability better than 0.02%/degree C, while the center frequency of the crystal filters will not change by more than 0.01% over the entire temperature range of 0°C to +50°C.

1.2.5 DETECTOR FUNCTIONS. In spite of the tendency to reduce the number of detector functions actually utilized in RFI/EMC meters, a requirement for less commonly used functions will probably persist for some time. Two factors will be responsible. The first is that special signal types and measurements will require the use of these functions, and the second is that some specifications requiring such functions will probably remain in effect. The EMC-10, therefore, was designed to include a choice of RMS, CARRIER, QUASI-PEAK, + PEAK, - PEAK, and SLIDEBACK detector functions.

1.2.6 OUTPUT CAPABILITIES. Two separate output emitter followers are incorporated to provide video output for a high-impedance oscilloscope and audio output for low-impedance phones. In addition, the detector output can be fed to an external meter or used to drive the Y-axis of a recorder. X-axis information is also made available; this is a DC voltage which is a linear function of the frequency to which the EMC-10 is tuned. An isolating emitter-follower is used to provide this X-output without the danger of loading the VCO control voltage itself.

In addition to the detector output, several other signals are also furnished; the output selector switch controls which of these signals is actually presented at the coaxial connector. The 100 kHz IF is made available for predetection recording and/or analysis. Also available is a TRACKING output -- a CW signal equal in frequency to the signal to which the instrument is tuned anywhere in the range of 20 Hz - 50 kHz. It is obtained by heterodyning the output of the VCO with that of a 100 kHz crystal-controlled oscillator. The EMC-10 can thus furnish its own CW signal which can be applied to measure the response of the network or device connected to its input. A third output which can be selected is the RESTORED signal, an amplified replica of the signal being fed into the EMC-10 at the frequency to which the instrument is tuned. This signal is obtained by heterodyning the actual 100 kHz IF signal with the output of the VCO.

A BFO function is included to assist in the identification of signals by an operator employing earphones. An audible signal is obtained by

actuating an oscillator which beats with the 100 kHz IF signal.

1.2.7 OTHER DESIGN FEATURES. In order to permit use as an RFI/EMC meter in the presence of strong fields, close attention has been accorded to shielding. Magnetic and electrostatic shields are employed wherever needed around sensitive circuits. The power supply battery section is compartmented and shielded so as not to contaminate the functional circuitry. The main instrument case is fully welded and its intersection with the front panel fully gasketed.

The EMC-10 is truly a portable instrument. The complete solid-state design has yielded a light-weight and compact instrument which can be operated from its own internal battery, independent of any outside source. An easily installed cover, Model EAC-10, for the front panel renders the entire instrument splash proof and ready to be carried to the field.

For laboratory use, the EMC-10 can be operated either from its internal battery, from an external AC source, or from an external DC source. Recharging of the internal battery is accomplished automatically whenever the AC line cord is connected to a proper source. Rack mounting in a standard 19-inch rack is readily accomplished by the attachment of two simple mounting flanges.

Frequency calibration is accomplished by turning the front panel, counter-type frequency indicator to 0.0 Hz. This calls for a VCO frequency equal to the IF of 100 kHz. Then the ZERO frequency control is adjusted for peak indication on the front panel meter. This means maximum leakage of the VCO into the IF which occurs when its frequency equals exactly 100 kHz.

The signal used for amplitude calibration is obtained by heterodyning the output of the VCO with the output of a 100 kHz crystal-controlled oscillator. This TRACKING signal, which occurs at the same frequency as indicated by the front panel indicator, is compensated to provide the same amplitude at all frequencies. Through internal switching, a precise amount of this signal is fed back to the instrument input. Full-scale meter deflection in the CAL position indicates that the instrument is calibrated.

1.2.8 PICKUP DEVICES. For RFI/EMC applications three pickup devices are available. For measurement of magnetic fields, a multiple-turn loop, Model ALP-10, is used. For electric field measurements, the pickup device utilized, Model PEF-10, is a very high input impedance amplifier, to whose input a capacitive field probe is connected. Solid-state circuitry of basic emitter-follower design then permits signal transfer to the EMC-10 through a conventional coaxial cable at 50-ohm impedance. For conducted measurements, the pickup device employed is a current probe, Model PCL-10, which clamps around the conductor being measured.

1.2.9 APPLICATIONS. After familiarization with the instrument, the user will find that the wide latitude of control provided creates many secondary applications for which the instrument is ideally suited. The instrument may be used as a signal generator, a frequency selective voltmeter, a complete audio wave analyzer, a vibration (or acoustic) analyzer, a sensitive wide band video receiver, a tunable high-sensitivity null detector, and an instrument for the determination of shielding effectiveness. In addition to the wide range of possible applications, the flexibility of the instrument is evidenced by the variety of readout and control equipment that may be operated simultaneously. This versatility is displayed in Figure 1.1 where such a multiple operation is depicted.

Interference Analyzer Model EMC-10 is the first of a new generation of instrumentation for RFI/EMC measurements. Its capability for voltage tuning and rapid automatic scanning enhances its value both as an RFI/EMC meter and as a wave analyzer, and it can be used, in conjunction with a conventional oscilloscope, as a spectrum analyzer. Its high degree of sensitivity and amplitude accuracy makes the EMC-10 an instrument of great convenience which can be used for years to come.

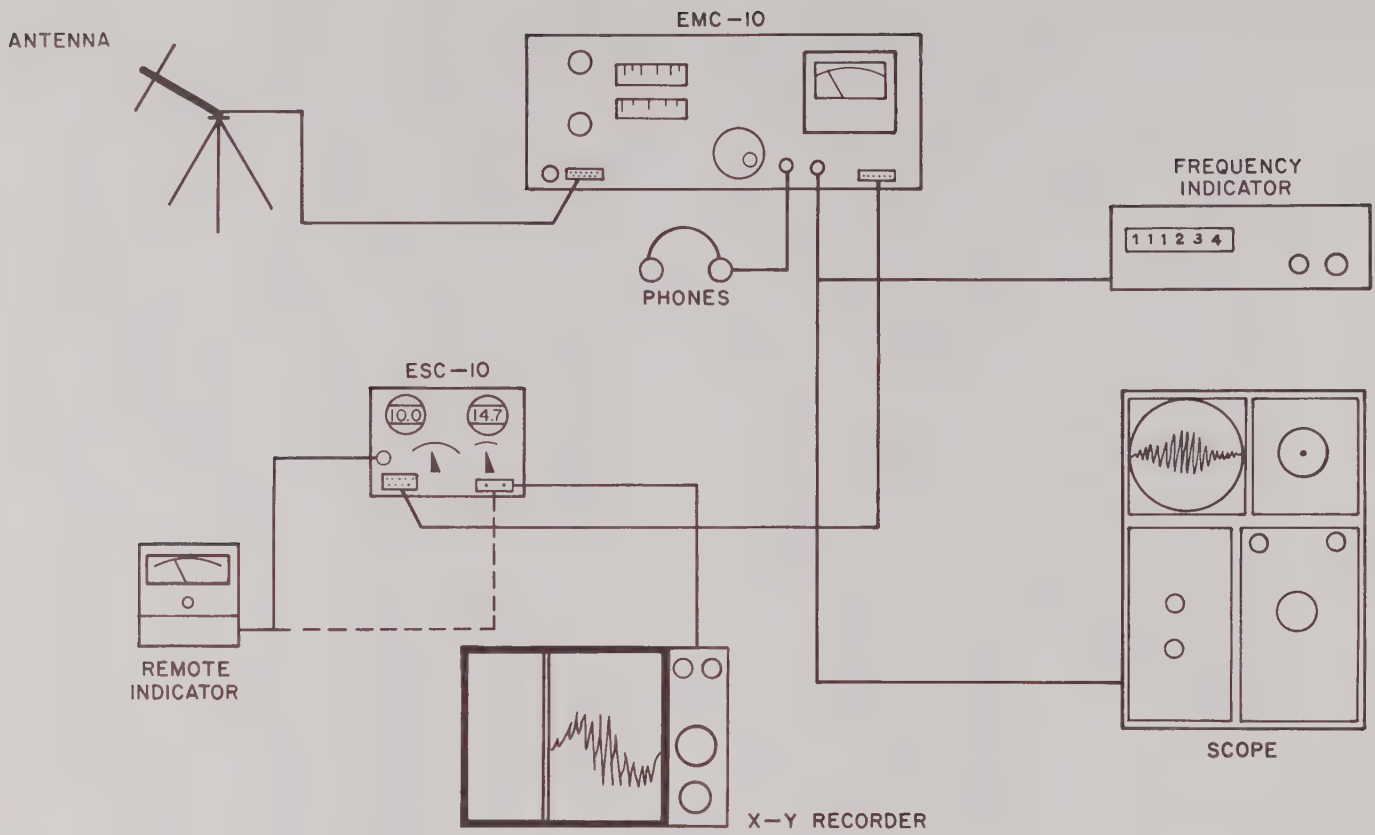


Figure 1.1 Multiple Setup for Remote Display and Control

SECTION II
THEORY OF OPERATION

2.1 GENERAL

Interference Analyzer Model EMC-10 is a voltmeter with two basic modes of operation: wideband and selective. In the wideband mode of operation, the instrument acts as a sensitive two-terminal voltmeter with a band pass of 20 Hz to 500 kHz. In the selective mode, the instrument becomes an electronically-tunable, heterodyne voltmeter, with several selectable steep-skirted pass bands.

Making reference to Figure 2.1 and the schematic diagrams (see Section VII), the following paragraphs trace and describe the instrument's primary circuitry.

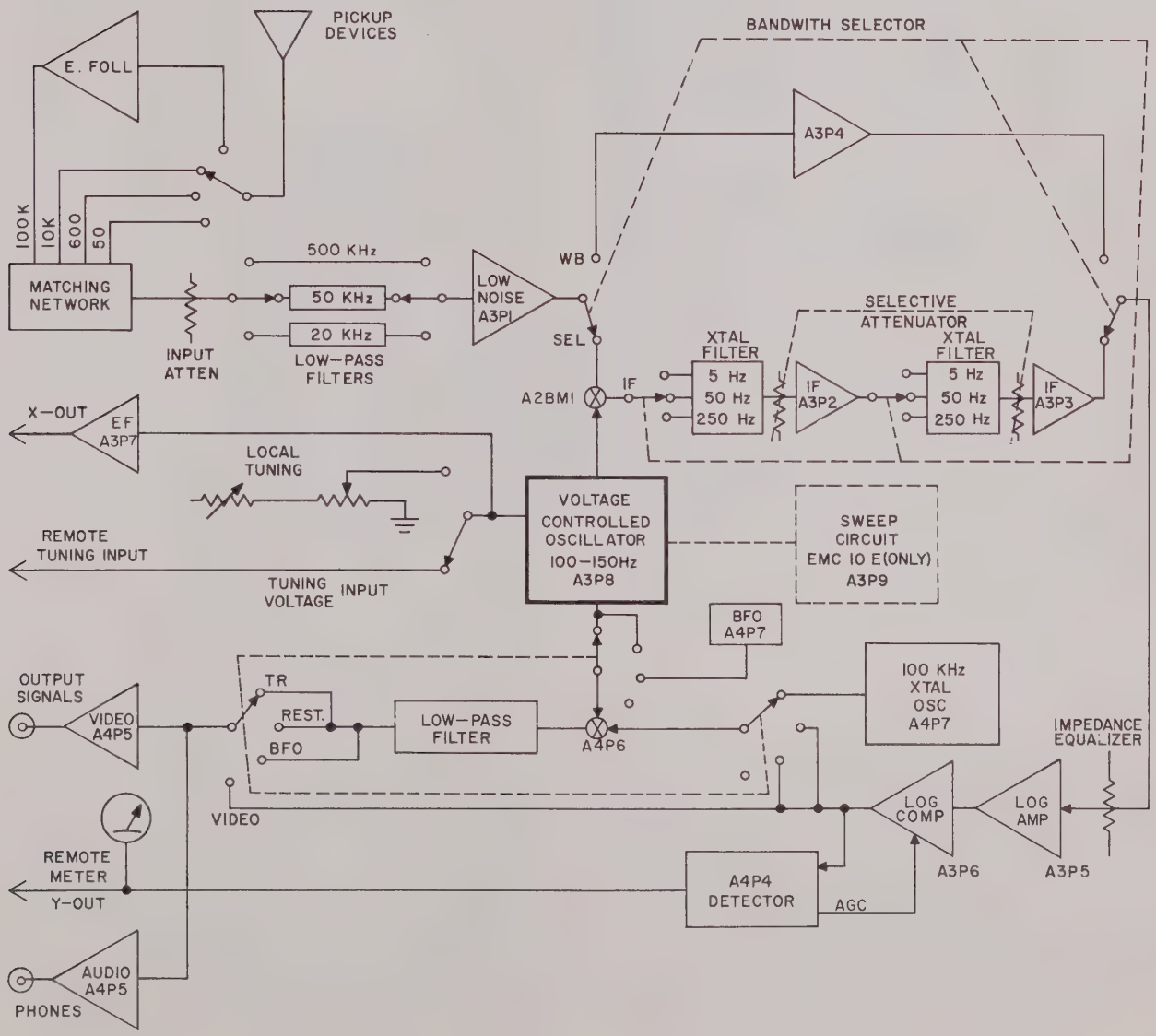
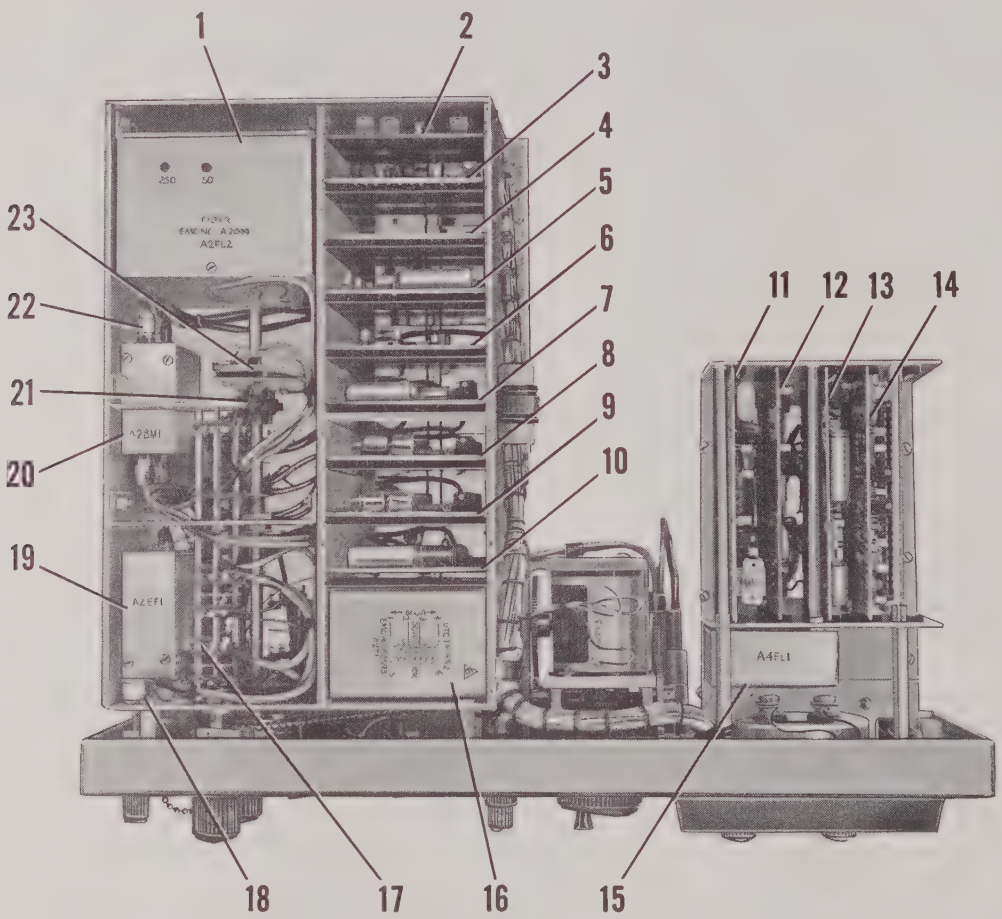


Figure 2.1 Block Diagram - Interference Analyzer, Model EMC-10

2.2 INPUT CIRCUITS

An incoming signal is first applied to an impedance matching network, after which it is fed to the input attenuator (Wideband Range Selector). When impedances of 50 or 600 ohms are selected, the impedance matching is accomplished by a transformer whose output impedance is 10 K ohms. When input impedance of 100K ohms is selected, an emitter follower is utilized ahead of the 100 K ohms attenuator to convert the impedance to 10 K ohms.

After impedance transformation and/or attenuation, the incoming signal is fed to either a low pass filter with a cutoff frequency of 20 kHz, or a low pass filter with a cutoff frequency of 50 kHz, or is fed directly (in the 500 kHz setting) to the low noise pre-amplifier (A3P1). (Refer to Figure 2.2 for location of referenced circuit boards.)



1. Crystal filter A2FL2
2. Auto scan PCB A3P9 (EMC-10E only)
3. VCO PC A3P8
4. AFC PCB A3P7
5. Detector driver PCB A3P6
6. Log amplifier PCB A3P5
7. Wideband amplifier PCB A3P4
8. IF amplifier PCB A3P3
9. IF amplifier PCB A3P2
10. Low noise preamp. PCB A3P1
11. Tracking-BFO oscillators PCB A4P7
12. Tracking-restored-BFO mixer amplifier PCB A4P6
13. Audio amplifier PCB A4P5
14. TVM PCB A4P4
15. 50 kHz low pass filter A4FL1
16. Matching transformer A2T1
17. Wideband range attenuator assembly
18. Gain potentiometer A2R1
19. Emitter follower A2EF1
20. Balanced modulator A2BM1
21. Microswitch A2S5A
22. Phono plugs, L.O. input
23. Microswitch A2S5B

Figure 2.2 EMC-10 Top View, Covers Off

2.3 WIDEBAND AND SELECTIVE SWITCHING

The output of the low-noise amplifier is fed to a microswitch (A2S5A). When wideband operation is chosen, the signal is switched to the wideband amplifier (A3P4), amplified, and then fed through another microswitch (A2S5B) to the log amplifier (A3P5).

When selective operation is chosen, the output of the low-noise amplifier (A3P1) is switched through microswitch (A2S5A) to the balanced modulator (A2BM1). The second input of the balanced modulator is fed by the voltage controlled oscillator (A3P8).

The output of the balanced modulator is fed to a bandpass crystal filter (A2FL2F) having a center frequency of 100 kHz, and switchable bandwidths of 5, 50, or 250 Hz (3 dB points).

From the output of the filter the signal is fed to the SELECTIVE RANGE attenuator which provides 20 dB attenuation in the 100 mV position and 40 dB attenuation in the 1 mV position. From the attenuator output the signal is fed to the first IF (A3P2), amplified and fed to crystal filter (A2FL2R) and then to a second section of the SELECTIVE RANGE attenuator, which provides 20 dB attenuation in the 1 mV position and 40 dB attenuation in the 10 mV position. In the .1 mV position neither attenuation is in the circuit. Above 1 mV level, attenuation is accomplished in the wideband attenuator as explained previously.

Following A1S5B is an attenuator ganged to the IMPEDANCE selector. By inserting a loss equal to the gain of the input transformer, a constant full-scale voltage is maintained regardless of input impedance for both wideband and selective operation.

The gain of the selective channel, consisting of balanced modulator, crystal filters, and IF amplifiers is adjusted to equal that of the wideband amplifier (A3P4).

2.4 VOLTAGE CONTROLLED LOCAL OSCILLATOR (VCO)

The VCO is basically an astable multivibrator whose output frequency is proportional to an applied DC voltage. As this frequency controlling voltage is varied from approximately zero voltage DC to 1.5-volts DC, the VCO output frequency varies from 100 kHz to 150 kHz. The output of the VCO heterodynes with the incoming signal in balanced modulator (A2BM1) to produce an IF of 100 kHz. For example, if the incoming frequency is 10 kHz, the VCO is set to 110 kHz to yield an IF of 100 kHz.

2.5 COMPRESSION AND DETECTION

Either the wideband amplifier or the 100 kHz IF (in selective operation) is then fed to the log amplifier (A3P5). The detector driver (A3P6) and the TVM (A4P4) compress the dynamic range of the signals fed through them by means of an instantaneous AGC loop. The resulting output (nearly logarithmic) is amplified by the detector driver and then detected in the TVM (A4P4), with the time constant switched to furnish a selected detector function. The TVM drives the front panel meter.

2.6 RESTORED, TRACKING AND BFO OUTPUTS

A second balanced modulator-mixer circuit is utilized to provide two useful special outputs. To obtain the TRACKING output, which is a constant-level sine wave produced at the frequency to which the instrument is tuned between 20 Hz and 50 kHz, a 100 kHz crystal controlled oscillator (A4P7) signal is fed to this second balanced modulator (A4P6) and heterodyned with an amplified sample of the local oscillator signal. Thus, the tracking signal is always at the frequency to which the instrument is tuned.

To obtain the RESTORED output, the VCO output is heterodyned with the IF produced by an incoming signal to obtain an output equal in frequency to the incoming signal, and whose amplitude varies as that of the incoming signal. However, this RESTORED signal has been subjected to IF selectivity and is thus a filtered replica of the incoming signal.

The BFO signal is obtained by heterodyning the 100 kHz IF with the output of a 101.0 kHz oscillator to achieve an output of approximately 1000 Hz which, when used in conjunction with earphones, aids in tuning and in recognizing signals.

2.7 IF AND VIDEO OUTPUTS

The IF and VIDEO outputs are both amplified pre-detection signals extracted just prior to the detector driver, the former being available during selective operation, and the latter during wideband operation.

The audio output is the same signal as the VIDEO output, except that it has been amplified by a high-gain, 100 mW audio amplifier (A4P5) with a high-frequency cutoff at approximately 10 kHz.

2.8 POWER SUPPLY

The EMC-10 series Interference Analyzers are designed for use on 110-220 VAC, 50-450 Hz, or battery operation in portable applications. The unique part of the power supply is the 30 cell center-tapped, nickel-cadmium battery. A constant current source, made up of A1Q1, A5CR5, A5R1 and A5R2 is supplied by the power transformer (A5T1), diode bridge (A5CR1-A5CR4) and filter capacitor (A5C1). When the instrument is connected to the AC power line and turned off, a charging current of 120 milliamperes is fed to the battery to maintain the proper terminal voltage. The battery can absorb this small amount of charging current indefinitely. When connected to the AC power line and turned on, a trickle charge of approximately 45 milliamperes is fed to the battery. Plus and minus raw voltages from the battery are supplied to the unit through the power switch. Provision is made for connection of an external DC source of 30-38 volts through two jacks (A5J3 and A5J4) at the rear of the cabinet. Changeover from 110 VAC to 220 VAC operation is effected with a switch also located on the power supply panel at the rear of the cabinet.

Two independent series regulated supplies provide plus and minus 12 volts to all critical circuits. Early production models had potentiometers to adjust each supply to precisely 12 volts. Serial numbers 10200 and later have selected precision resistors to minimize microphonics.

2.9 EMC-10E SWEEP CIRCUITS

A single linear sweep is generated by circuit A3P9 in "E" models. A unity gain operational amplifier, having extremely high input impedance senses the voltage appearing on a low leakage, 10 microfarad capacitor A1C. The voltage across the capacitor rises at a rate determined by the setting of the BANDWIDTH control which inserts A3P9R1, 2, or 3 through 10 between the input of the amplifier and its offset output. The offset, provided by reference element A3P9Q5 and A3P9R18 forces a constant current through A1C resulting in a linear voltage rise. Initial conditions are placed on this capacitor by the setting of the FREQUENCY potentiometer and the sweep START push button.

SECTION III
OPERATION INSTRUCTIONS

3.1 GENERAL

3.1.1 This section provides instructions for operation of the EMC-10 in all modes. Instructions are also included for pre-operating calibrations, accessory operation, and meter reading interpretation.

CAUTION

Read all the material in this section carefully before attempting to operate the EMC-10. Improper operation can cause costly damage to the instrument.

3.2 UNPACKAGING

3.2.1 Remove the instrument carefully from the shipping carton and examine thoroughly for shipping damage. If there is any damage, replace the instrument in the shipping carton and immediately inform the manufacturer and the shipping company of the nature of the damage, the serial number of the instrument, the delivery date, and the invoice number.

3.2.2 Check contents of the carton against shipping slip to be sure that all components and accessory items ordered are present. Notify the manufacturer immediately of any missing items.

3.3 ELECTRONIC SHIPPING DAMAGE

3.3.1 Before leaving the factory, this instrument was subjected to a complete operational check. However, it is possible that electronic damage may have occurred in transit. It is desirable, therefore, to check the operation of the instrument as soon as possible after unpackaging.

To do so, perform the calibration tests outlined in paragraph 3.12. If the instrument does not calibrate using the referenced procedures, inform the manufacturer giving the basic information required in paragraph 3.2.1.

3.4 POWER REQUIREMENTS

3.4.1 Unless otherwise specified on the purchase order, the EMC-10 is normally wired for operation with the following power supplies.

a) Internal (self-contained) battery operation.
b) External 105 to 130-volt AC, at 50 to 450 Hz.
c) External 30 to 38-volt DC.

NOTE

A switch on the battery compartment cover changes power supply to operate from 105 to 130 volts AC or 210 to 260 volts (see SECTION 4.8).

3.5 BATTERY POWER SUPPLY

3.5.1 The battery pack (BAT-10) supplied with the instrument incorporates multiple nickel cadmium cells in a modular design which provides for individual cell replacement. The battery can be used for eight hours of sustained operation without recharging. It will fully recharge after such usage in sixteen hours. To recharge the battery, connect the instrument to an external AC source. Battery charging is automatically controlled by the instrument and will occur with the POWER switch either in the ON (up) or OFF (down) positions. This provides operating capability during the recharging phase.

3.5.2 Because testing with this instrument is usually performed sporadically for short periods of time, it is difficult to know the charge condition of the battery. The front panel Battery Test Switch indicates only the relative charge condition of the battery. It does not indicate exact degree of charge or balance condition of the battery or of voltage to the instrument.

3.5.3 Inability to calibrate this instrument, in amplitude and/or frequency, may also be an indication of low battery charge, and/or improper voltage balance.

3.5.4 For most efficient operation this instrument should be connected to an external AC source, whether turned OFF or ON, and kept on charge even when in storage. It cannot be overcharged.

3.5.5 The internal battery should be used when the instrument is fully disconnected from the power line. Normally the instrument should be kept on AC and as near full charge at all times for best overall operation.

3.5.6 The instrument can also be operated from an externally connected battery. To do so, connect the battery to the two banana jacks on the rear panel (see Figure 4.1).

CAUTION

Connect the red jack to the positive terminal and the gray jack to the negative terminal. Do not ground these terminals or establish a reference ground. Let the external supply "float" above ground. The internal battery must be left in the instrument and connected when the instrument is being operated from external AC or DC operation to provide proper capacity.

3.6 INSTALLATION

3.6.1 The EMC-10 is designed for bench-top operation, field-portable operation, or for installation in a conventional 19-inch equipment rack.

3.6.2 Rack mounting requires the use of two adapter mounting brackets (ABM-10). Using these brackets, install the instrument by the following procedure.

a) With six 3/8-inch No. 10-32 screws, fasten brackets to sides of instrument at matching screw holes.
b) Before installing in equipment rack, provide underneath support sufficient to carry the weight of the instrument.

3.7 FRONT PANEL CONTROLS

3.7.1 All operating controls for the EMC-10 are located on the front panel. These controls are illustrated in Figure 3.1 and described below. Figure 3.3 shows the location of the additional controls required on the EMC-10E version. Their function is also described in the following paragraphs.

3.7.2 GAIN CONTROL. This control is set at the factory so that adequate reserve is available for calibration. After calibration the control is normally moved from this setting only in applications where it is necessary to know the relative rather than the absolute amplitude of two signals.

3.7.3 WIDEBAND RANGE CONTROL. This selector provides for proper front-end attenuation ahead of the preamplifier stage. Use of proper attenuation will prevent preamplifier overload. However, this selector should be operated only when the BANDWIDTH selector is in the WIDEBAND position. The amplitude selected is displayed both in terms of VOLTAGE and DB ABOVE 1uV, in the display to the right of the control. This amplitude indication corresponds to the full-scale reading on the large panel meter.

3.7.4 SELECTIVE RANGE CONTROL. The function of this control is the same as the WIDEBAND RANGE control, when the instrument is operating in the selective mode.

CAL positions also appear in the window displays. The function of these positions is indicated in paragraphs 3.12.4 and 3.12.5.

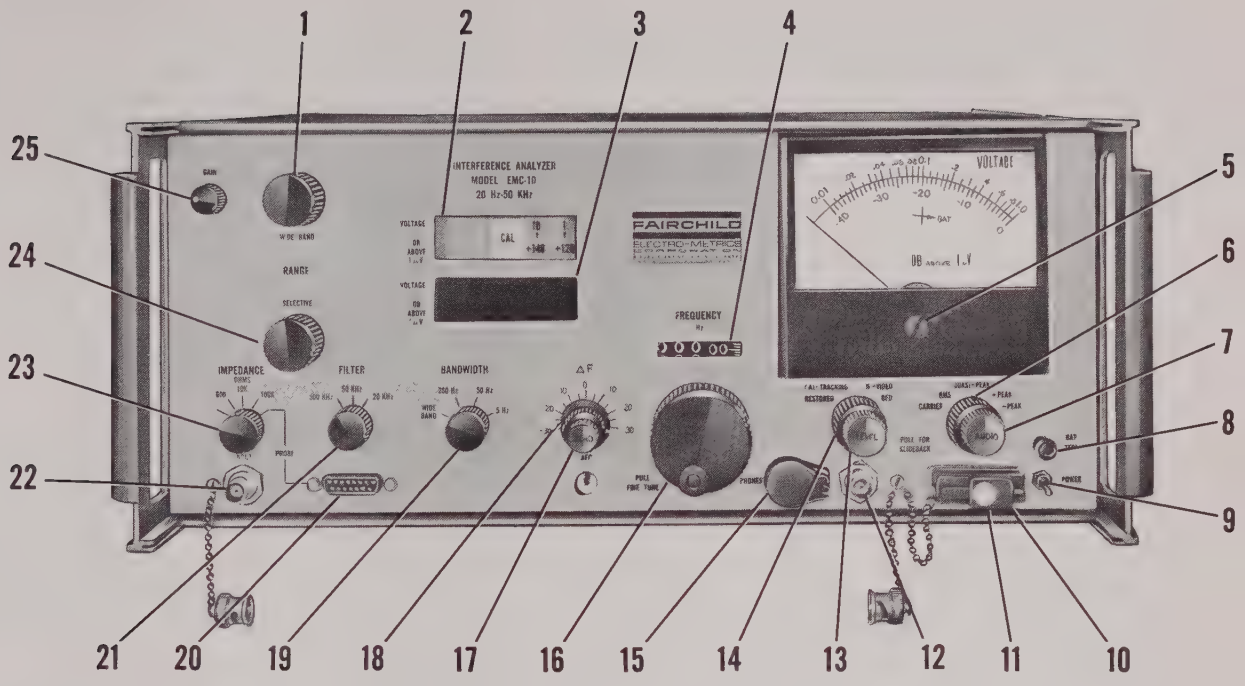
3.7.5 IMPEDANCE SELECTOR. Use of this control establishes the proper input impedance as required by the particular application.

3.7.6 FILTER SELECTOR. This control is operative in both the wideband and selective modes, and is used to limit upper-end coverage of the frequency spectrum. If full wideband operation is desired, the switch should be left in the 500 kHz position for 10K and 100 K input settings and in 50kHz for 50 ohm and 600 ohm input settings.

3.7.7 BANDWIDTH SELECTOR. The four position BANDWIDTH selector is used to determine instrument operation in either WIDEBAND or any of three SELECTIVE passbands.

3.7.8 FREQUENCY CONTROL. When the instrument is in the SELECTIVE mode of operation, the frequency control knob is used to tune the instrument to the desired frequency. The tuned frequency is indicated on the digital display above the frequency control knob. The frequency control knob electronically controls the local oscillator frequency. This control is provided with two tuning rates. For coarse tuning, the control is pushed in. For fine tuning, the control is pulled out. This main frequency control does not function when the frequency is controlled from a remote location; however in the EMC-10E model, this control sets the low start point for AUTO SCANNING.

3.7.9 ΔF CONTROL. ΔF control is provided by the large knob concentric with the control marked ZERO. This continuously variable, vernier control provides extra-fine tuning of the



1. WIDEBAND RANGE switch
2. WIDEBAND RANGE display
3. SELECTIVE RANGE display
4. Digital frequency indicator
5. Meter zero set adjustment
6. Detector function selector
7. AUDIO/SLIDEBACK control
8. Battery test push-button switch
9. POWER switch (UP for ON)
10. Remote connector
11. Dummy plug
12. Output connector, BNC
13. LEVEL control, output
14. Function selector, output
15. Phone jack
16. Frequency control
17. ZERO set control
18. ΔF control
19. BANDWIDTH selector
20. PROBE input connector
21. Low pass FILTER selector
22. INPUT connector, BNC
23. IMPEDANCE selector
24. SELECTIVE RANGE switch
25. GAIN control

Figure 3.1 EMC-10 Front Panel Controls

local oscillator frequency over a range of ±30 Hz. The center frequency of operation, therefore, is equal to the digital indication plus or minus the ΔF setting.

3.7.10 ZERO CONTROL. This control is used in the pre-operational calibration of the local oscillator frequency.

3.7.11 DETECTOR FUNCTION SELECTOR. The outer concentric knob under the AUDIO control is used to select the desired detector function. CARRIER, RMS, QUASI-PEAK, + PEAK, - PEAK, or metered-SLIDEBACK detector functions can be chosen. An explanation of these detector functions is given in paragraph 3.8.

3.7.12 AUDIO CONTROL. This control provides output signal level adjustment at the audio output phone jack. The same knob, when pulled out, becomes the metered-slideback control. (This control should be turned all the way down except when the Function Selector Switch described below is in the BFO position.)

3.7.13 OUTPUT FUNCTION SELECTOR. The outer concentric knob located behind the LEVEL control provides the choice of outputs at the BNC output connector. Available output signals at this connector are RESTORED, TRACKING, IF-VIDEO, and BFO.

3.7.14 LEVEL CONTROL. This control is used to vary the amplitude of the selected output signal.

3.7.15 OUTPUT CONNECTOR J-5. This connector provides for the connection and operation of remote indication meters, remote tuning, and X-Y plotting. The outputs and their locations are shown in Figure 3.2.

3.7.16 POWER SWITCH. In order to activate the EMC-10 circuitry, the toggle switch marked POWER must be turned ON (up). The switch must be in the ON position even when operating from the internal power source.

3.7.17 BAT TEST SWITCH. This push-button switch, when depressed, yields a front panel meter indication of whether the voltage level of the internal battery power supply is sufficient for reliable operation.

3.7.18 ELECTRIC FIELD PROBE CONNECTOR. The main function of this connector is to provide power and calibration signals to the electric field probe capacitive antenna assembly, PEF-10, and to accept the incoming signal from this antenna. The operation of this accessory is described in paragraph 3.14.4.

3.7.19 REMOTE CONNECTOR DUMMY PLUG. When in place, this connector completes the internal circuitry of the EMC-10. The instrument will not operate without this connector in place unless the connection is completed by an external instrument. The instrument may be operated without the dummy plug in place only when connected to a remote indication meter, remote tuning control, or X-Y recorder.

3.8 DETECTOR FUNCTIONS

3.8.1 Each of the detector function circuits is used to fulfill specific applications. These are explained briefly in the following paragraphs.

3.8.2 CARRIER AND RMS. These positions are used to obtained a meter indication of the RMS value of the carrier whether modulated or unmodulated.

3.8.3 QUASI-PEAK. This detector function has been incorporated in the instrument design to provide a special measurement capability required by certain military specifications. This circuit has a charge-time constant of 1.0 millisecond and a discharge-time constant of 600 milliseconds. Further information will be found in the applicable military specifications.

3.8.4 + PEAK. This function is used to obtain a true peak reading of the positive half of signals.

3.8.5 - PEAK. This function is used to obtain a true peak reading of the negative half of signals.

3.8.6 METERED SLIDEBACK. This function is used to establish + or - peak readings through the use of an audible signal. Operation of this function is as follows.

a) Pull AUDIO control out for slideback operation and turn fully clockwise.
b) Place selector control in the + PEAK or - PEAK position as required.
c) Connect earphones (EEM-10) to phone jack on front panel.
d) Slowly turn slideback control counter-clockwise to point where signal is heard. Panel meter now indicates true peak value of signal.
e) AUDIO control must be pushed back in to return instrument to normal operation.

3.9 OUTPUT FUNCTIONS

3.9.1 For increased flexibility of operation, the EMC-10 has been provided with a multiple output signal capability. The nature of these outputs is described in the following paragraphs.

3.9.2 RESTORED. This output is available only when the instrument is operating in the selective mode. The signal generated is the amplified and filtered component of the input signal at the frequency to which the instrument is tuned. The signal is produced by heterodyning the IF signal with the local oscillator output.

3.9.3 CAL-TRACKING. The CAL-TRACKING output is a constant level CW signal with a frequency identical to that to which the instrument is tuned, as indicated on the digital display. This signal is produced by heterodyning the local oscillator output with a 100 kHz crystal oscillator signal. It is the same signal as used for calibration.

3.9.4 IF-VIDEO. The IF-VIDEO output signal is available in both wideband and selective operating modes. In the selective mode, the output is the 100 kHz IF signal. This signal is useful for pre-detection-type recording. When the instrument is in wideband operation, the output presented is the total amplified predetected input signal.

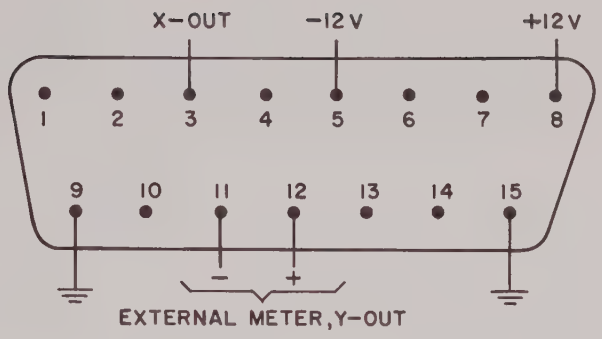
3.9.5 BFO. The beat frequency oscillator output signal is an audible "beat" note at the PHONES jack which is produced by mixing the IF signal with a 101 kHz oscillator signal. The "beat" note is useful as an audible tuning aid for locating signals.

3.9.6 X-Y OUTPUTS. Signal outputs are provided for both the X and Y coordinates required for X-Y plotting. These outputs are available at the 15 pin external receptacle J-5 (see Figure 3.2). The X-coordinate output is a DC signal referred to ground whose voltage is proportional to the instrument's tuned frequency. The Y-output is a DC signal whose voltage is proportional to the meter indication.

3.10 EMC-10E CONTROLS

Three controls unique to the EMC-10E are located to the right of the meter as illustrated in Figure 3.3.

3.10.1 OFFSET CONTROL. This screwdriver adjustment provides a supplemental zero adjustment for X-Y recorders useful for narrow-width scans.



Pin 3: X-output proportional to frequency
Pin 5: -12 volts, reg.
Pin 8: +12 volts, reg.
Pins 9 and 15: Ground
Pins 11 and 12: External meter - 1500 ohms, 1 mA.

NOTE: Pins 1 and 2 must be jumpered externally to complete the VCO control circuit.

Figure 3.2 Outputs at J5 Connector

3.10.2 START SWITCH. This push-button switch resets the sweep circuit to the frequency indicated on the FREQUENCY counter dial. Upon its release, the sweep circuit starts to sweep toward 50 kHz at a rate determined by the BANDWIDTH selector position.

3.10.3 AUTO SCAN/MANUAL SWITCH. This switch is normally positioned down in the MANUAL position. When automatic scanning is desired, this switch is placed in the AUTO SCAN, or up position.

3.11 GENERAL OPERATING CONSIDERATIONS

3.11.1 When operating the EMC-10, the following factors should be considered in determining the choice of control settings.

3.11.2 SENSITIVITY. The sensitivity of the instrument is determined by the bandwidth and the input impedance control settings. When measuring a CW-type signal, the sensitivity increases as the bandwidth is decreased. This is due to the reduction in internal noise at the narrower bandwidth. However, when a pulse type signal is being measured, sensitivity generally must be compromised and the bandwidth increased in order to encompass frequency components away from the center carrier frequency. In addition to bandwidth, the amount of input imped-

ance also determines the degree of internal noise and, consequently, the sensitivity. With any type of measurement, optimum sensitivity will be achieved by keeping the input impedance at the lowest practical level.

3.11.3 LOCAL OSCILLATOR LEAKAGE. At the low end of the instrument's operating range, the local oscillator frequency approaches that of the IF. Due to the increased proximity of the two frequencies, the LO leakage increases as the IF bandwidth is widened. Therefore, when sensitive measurements are being taken below 1,000 Hz, the bandwidth must be limited to prevent LO leakage. To obtain maximum sensitivity, it is suggested that the relationships presented in Table 3-1 be maintained. The column to the left in the table indicates the lowest frequency of interest, while the column to the right indicates the suggested bandwidth to be used.

TABLE 3-1

Bandwidth Settings for Optimum Sensitivity

Lower Frequency Limit (Hz)	Bandwidth (Hz)
1,000	250
200	50
20	5

3.11.4 ADDITIONAL LEAKAGES. Due to the high degree of sensitivity of the instrument, the leakage of internally-generated, high-level signals may occur. The tracking signal, in particular, is a relatively large signal with a frequency identical to that to which the instrument is tuned. Despite the extensive design measures taken to shield this source, some tracking signal may leak through either by conduction or radiation. To minimize this effect when the more sensitive ranges are utilized, set the output function selector switch to either IF or BFO and turn the LEVEL control fully counter-clockwise.

Another source of possible internal interference is the audio amplifier. Since the audio amplifier is a high-gain, high-power amplifier, its output may possibly be conducted or radiated back into the system. It is recommended, therefore, that the AUDIO control be turned fully counter-clockwise whenever measurements are being taken in the more sensitive ranges, and turned up only when the Output Control is in the BFO position.

When the instrument is connected to the loop antenna and earphones are being used to monitor the audio signal, magnetic oscillations in the earphone coils may be picked up by the antenna unless care is taken to keep the audio level

1. OFFSET control (for sector scanning)
2. START switch (push for start of scanning)
3. AUTO SCAN/MANUAL switch (up for automatic scanning)

Figure 3.3 EMC-10E Front Panel Controls

minimized and the earphones physically separated from the antenna by a distance sufficient to negate this effect.

3.11.5 IMPULSE MEASUREMENTS. When it is required to measure impulses, the problem of protection against preamplifier overload becomes very severe. Because of the very short time duration of the pulse, the metering circuit may not have a short enough charging time to indicate the full value of the impulse amplitude. For this reason it is recommended that the following procedures be used when impulse measurements are being conducted.

a) Set input FILTER selector to either 50 kHz or 20 kHz (20 kHz preferred) to limit energy spectrum.
b) Set BANDWIDTH switch to maximum position allowable for particular measurement.
c) Use slideback method for reading impulse amplitude.

To assure that there is no overloading of the preamplifier, attenuate the incoming impulse by any convenient amount, and ascertain that the meter reading has decreased by the same amount.

3.11.6 SIGNAL PER MHz. Because certain military specifications call for measurements per given bandwidth, a certain factor must be added to the reading for the proper conversion. Table 3-2 illustrates the factor to be added.

TABLE 3-2

Reading Conversion Factors

BANDWIDTH	DB ADDED TO CONVERT TO:	
	uV/kHz	uV/MHz
5 Hz	46 dB	106 dB
50 Hz	26 dB	86 dB
250 Hz	12 dB	72 dB

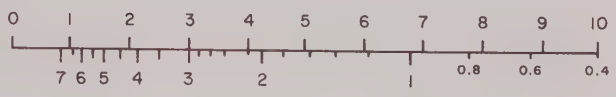
EXAMPLE: Bandwidth is 50 Hz meter reading 26 dB above 1uV.

To convert to dB above 1 uV/kHz
26 + 26 = 52 dB uV/kHz

3.11.7 TANGENTIAL SENSITIVITY. Tangential sensitivity means that if a signal, whose level equals that of the instrument's internal noise, is applied to the input, an increase of 3 dB in meter indication will result. Thus, when the noise of the instrument is .003 uV and a signal of .003 uV is applied to the input, the resulting meter reading will be 3 dB higher, or .0042 uV.

For conversion of other signals whose levels are close to that of the internal noise, use the chart below.

Increase in dB in meter reading over noise level when input signal is applied.



Amount of dB to be subtracted from total meter reading to find actual signal level.

EXAMPLE:
Internal Noise . -50 dB (above 1uV)
Meter indication with signal applied . . . . . -45 dB
Increase in meter reading (50-45) . . . . . 5 dB
From chart: amount to be subtracted . . . . . 1.65 dB
Actual signal level equals:

[(-45) - 1.65 = -46.65 dB (above 1uV)]

3.12 PRE-OPERATIONAL CALIBRATIONS

3.12.1 Prior to recording measurements, it is recommended that the following front panel calibrations be performed. This will insure information reliability.

3.12.2 METER ZERO ADJUSTMENT. Before turning the instrument ON, check the position of the front panel meter indicator. When the power is OFF, the indicator should rest on the zero calibration mark. If it does not, reset to zero using the mechanical adjustment screw on the meter panel (see Figure 3.1).

3.12.3 FREQUENCY CALIBRATION (Preferred Method). This calibration is used to set and maintain the relationship between IF and local oscillator frequencies. Proceed with the calibration as follows.

a) Disconnect input signal cable.
b) Set front panel controls as follows.

Input IMPEDANCE. . . . . 50 ohms
WIDEBAND RANGE . . . . . .1 mV
SELECTIVE RANGE. . . . . 100 uV
FILTER . . . . . 50 kHz
BANDWIDTH . . . . . 5 Hz
Frequency Indication 00000
Output . . . . . .IF VIDEO
Detector . . . . . .CARRIER

c) Turn power ON, allow 30 minute warm-up.
d) Set ΔF control to 0.0 Hz.
e) Slowly adjust ZERO control to achieve maximum meter indication.
f) If necessary, reset SELECTIVE RANGE switch to obtain on-scale reading.

When a maximum meter reading has been obtained and carefully peaked, the IF and local oscillator frequencies are attuned and the instrument is frequency calibrated for all frequencies within the instrument's operating range, as indicated on the digital indicator.

3.12.4 FREQUENCY CALIBRATION (Alternate Method). This calibration is also used to set up and maintain the relationship between IF and local oscillator frequencies, but is usually a time-saver when followed immediately by amplitude calibration due to the similarity of initial front panel control settings.

Proceed with the calibration as follows:

a) Disconnect input signal cable.
b) Set front panel controls as follows:

Input IMPEDANCE . . . . .50 ohms
WIDEBAND RANGE . . . . . CAL
SELECTIVE RANGE . . . . . CAL
FILTER . . . . . 50 kHz
BANDWIDTH . . . . . 5 Hz
Output . . . . . .CAL-TRACKING
Detector . . . . . .Carrier
Frequency Indication 00000

c) Adjust ZERO control very carefully to maximum null position. (A slight adjustment of ΔF control may be required for maximum null.)
d) Instrument is now frequency calibrated.

3.12.5 AMPLITUDE CALIBRATION. In order to calibrate the instrument's amplitude response proceed as follows:

a) Disconnect input signal cable.
b) Set controls as follows, with frequency control set at a point between 20 kHz and 45 kHz.

Input IMPEDANCE . . . . . 50 ohms
WIDEBAND RANGE . . . . . CAL
SELECTIVE RANGE . . . . . CAL
FILTER. . . . . 50 kHz
BANDWIDTH . . . . . WIDEBAND
Output . . . . . CAL-TRACKING
Detector . CARRIER for carrier measurements or +PEAK for peak measurements.

c) Turn POWER switch ON.
d) Adjust gain control carefully for full scale deflection. The instrument is now calibrated for WIDEBAND usage.
e) Change BANDWIDTH switch setting to 5 Hz. If exact full scale is not obtained, the gain control should be adjusted to full scale for making measurements with this bandwidth.
f) Calibration for measurements in 50 Hz bandwidth and 250 Hz bandwidth should be handled the same as for 5 Hz.
g) Using the frequency control, tune instrument through frequency range of interest, and note meter indications.
h) If the meter reading remains constant within ±0.5 dB above 100 Hz, the instrument is amplitude calibrated. (It may drop as much as 3 dB at the 20 Hz point.)

3.13 OPERATING PRECAUTIONS

3.13.1 AVOIDING OVERLOAD. Prior to instrument operation it is essential that the following precautionary procedures be observed. This will prevent preamplifier circuit overload and incorrect measurements as a result of high level, off-frequency signals.

a) Connect signal cable to front panel input connector and set input IMPEDANCE selector switch to proper position.

b) Before turning instrument ON, place BANDWIDTH selector in WIDEBAND position and FILTER selector at 500 kHz.

c) Set WIDEBAND RANGE selector at 10 V.

d) Turn power ON and note meter deflection.

e) Progressively decrease wideband range until maximum on-scale indication is obtained.

f) Proceed with measurements in wideband or selective mode as desired.

CAUTION

While operating in the selective mode, do not change or reduce front end attenuation thus established, or change gain control.

g) If spectrum of interest is below 50 kHz or 20 kHz, FILTER switch may be set to 50 kHz or 20 kHz for maximum rejection of higher frequencies.

CAUTION

Do not attempt to measure voltages above one-volt with an input impedance of less than 10K ohms (IMPEDANCE selector). A larger voltage may cause erroneous readings and/or damage to critical circuitry.

3.14 SPECIFIC OPERATING PROCEDURES

3.14.1 The following paragraphs give the procedures to be used for specific applications. If the instrument is to be used for a unique application such as MIL-STD-826A tests, approved procedures may be obtained from Electro-Metrics or the local representative. Other applications requiring modification of procedures should be discussed with the local representative.

3.14.2 RELATIVE READINGS. When the instrument is used to obtain the relative rather than the absolute amplitudes of two signals, as in harmonic measurements, the GAIN control can be used to set a convenient level at one signal frequency.

EXAMPLE: Signal reads 0.4 volts and -8.0 dB above 1uV; set the signal to 0.1 volts and -20 dB above 1uV.

The attenuator can now be changed 20 dB (one step) to obtain a full-scale reading. This will provide an easier reference for relative measurements.

NOTE

Always return the GAIN control to the position established by the amplitude calibration procedure (see paragraph 3.12.5) after relative readings are completed.

3.14.3 MAGNETIC FIELD MEASUREMENTS. To obtain magnetic field measurements, proceed as follows.

a) Using 25-foot coaxial cable CAC-10, connect loop antenna ALP-10 to instrument at BNC INPUT connector.
b) Set IMPEDANCE selector switch at 50 ohms.
c) Set detector selector to + or - Peak.
d) Set BANDWIDTH selector to WIDEBAND.
e) Set WIDEBAND RANGE selector to 10V.
f) Turn power ON and note meter deflection.
g) Progressively decrease wideband range until maximum on-scale reading is obtained.
h) Orient loop antenna for maximum reading.
i) Set BANDWIDTH selector to bandwidth desired.
j) Set detector selector to function desired.
k) Set FREQUENCY control to required frequency.
m) Note meter reading and adjust SELECTIVE RANGE switch until maximum on-scale reading is obtained.
n) Note meter reading and frequency.
p) Convert reading to field strength or to equivalent uV/meter using loop antenna nomograph (see Figure 7.1-7.3).

3.14.4 ELECTRIC FIELD MEASUREMENTS. To measure electric field strength, proceed as follows.

a) Amplitude calibrate instrument at 20 kHz (center frequency and 50 Hz bandwidth) (see paragraph 3.12.5).
b) Using multiple conductor cable provided, connect electric field probe antenna (PEF-10) to instrument at 15 pin receptacle marked PROBE. (No cable should be connected to the BNC input connector.)
c) Set front panel controls as follows:

IMPEDANCE	PROBE
WIDEBAND RANGE	CAL
SELECTIVE RANGE	CAL
FILTER	50 kHz
BANDWIDTH	50 Hz
Output selector	CAL-TRACKING
Detector selector	As Applicable

d) Unscrew dipole arms from the antenna assembly.

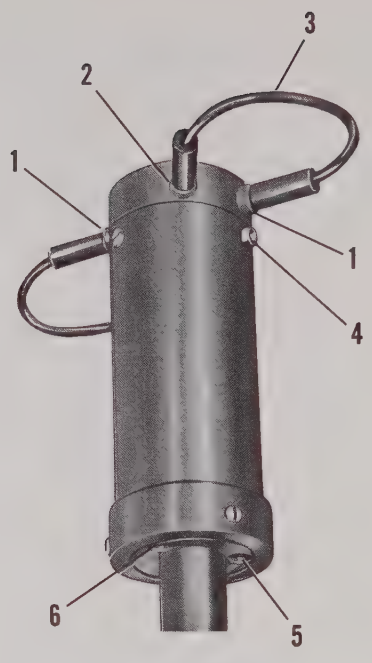
e) Connect short calibration cables provided between dipole arm sockets (J2, J4) and nearest banana jacks (J1, J5).
f) Turn instrument POWER switch ON.
g) Adjust SELECTIVE RANGE switch to obtain on-scale meter reading.
h) Adjust balance control on antenna assembly (see Figure 3.4) until meter null is obtained.
i) Disconnect one calibration cable from banana jack and connect to ground, (J3).
j) Reposition SELECTIVE RANGE switch to CAL.
k) Adjust antenna assembly gain control (see Figure 3.4) until -22 dB reading is obtained on meter.
m) Reconnect calibration cable to banana jack.
n) Readjust SELECTIVE RANGE switch to obtain null meter reading again.
p) Repeat steps (h) through (p) as required until null reading is obtained with both cables connected, and -22 dB reading is obtained with one cable to ground without further adjustment of controls.
q) Disconnect calibration cables and screw on dipole arms.
r) Proceed with measurements as outlined in paragraph 3.14.3(c) through (k) and note meter readings.
s) Add 32 dB to meter reading to obtain accurate volts per meter reading.

3.14.5 CONDUCTED MEASUREMENTS. When the instrument is to be used to measure signals conducted in a cable, proceed as follows.

a) Using coaxial cable CAC-10, connect clamp-on current probe PCL-10 to BNC INPUT connector on instrument.
b) Clamp probe to cable and secure with locking screw.
c) Conduct measurements as outlined in paragraph 3.14.3(b) through (n) and note meter readings.
d) Add conversion factors shown in Figure 7.4.

3.14.6 REMOTE METER INDICATION. To provide remote read-out capability proceed as follows.

a) Turn instrument power OFF.
b) Remove dummy plug from remote connector (see Figure 3.1).
c) Connect remote meter RIM-10 to the 15 pin remote connector.
d) Turn instrument power ON.
e) Read indications directly on remote meter. (This reading should be the same as that on the front panel meter.)



1. Banana Jack (J1, J5)
2. Dipole Arm Socket (J2, J4-not shown)
3. Calibration Cable
4. Ground Banana Jack (J3)
5. Bal. Control
6. Gain Control

Figure 3.4 Electric Field Probe Antenna Controls

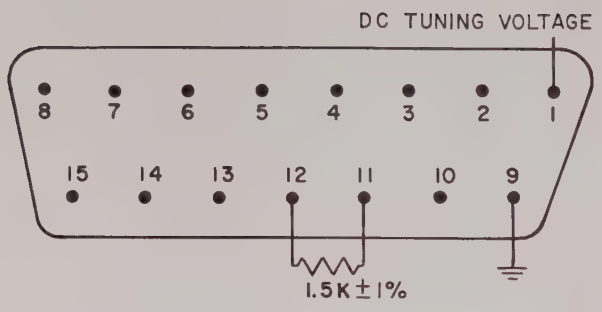
3.14.7 REMOTE TUNING. Because the instrument incorporates a voltage-controlled local oscillator (VCO), it is possible to tune the instrument electronically from a remote location. To do so, proceed as follows.

a) Turn instrument power OFF.
b) Remove dummy plug from remote connector (see Figure 3.1).

NOTE

It is recommended that the dummy plug be left on the chain connected to the instrument and a new plug be used for connecting to remote tuning equipment. This leaves dummy plug available for use when remote control is not needed.

c) Wire connector as shown in Figure 3.5 to external DC voltage variable from zero to + 1.5 volts.
d) Turn instrument power ON.
e) Set output function selector switch to CAL-TRACKING position.



For remote tuning, remove dummy plug and connect plug wired as follows:
Pin 1: feed zero to +1.5 volts to tune from 20 Hz to 50 kHz
Pin 9: ground for above.
Pins 11 and 12: connect 1.5 K, 1% resistor between.

Figure 3.5 Remote Tuning Plug

f) Connect external frequency counter to BNC output connector.
g) Adjust externally applied DC voltage until counter reads 20 Hz making whatever markings on DC control are appropriate to returning to the same DC level at a later time.
h) Adjust externally applied DC voltage until counter reads 50 kHz making whatever markings on DC control are appropriate to returning to the same DC level at a later time.
i) The range of 20 Hz to 50 kHz now will be linear with voltage applied and the counter can be disconnected if desired.
j) Adjust external voltage until frequency of interest appears on counter.
k) Proceed with measurements.

3.14.8 MANUAL X-Y PLOTTING. To graphically record meter indications connect and calibrate an X-Y recorder, such as Electro-Metrics Model EXY-125, as follows.

a) Turn instrument POWER switch OFF.
b) Remove dummy plug from 15 pin remote connector (see Figure 3.1, Item 11).
c) Connect X-terminals of recorder to pins 3 and 9 of remote connector (see Figure 3.6, ground pin 9) to recorder chassis.
d) Connect Y-terminals of recorder to pins 11 and 12 of remote connector (see Figure 3.6).

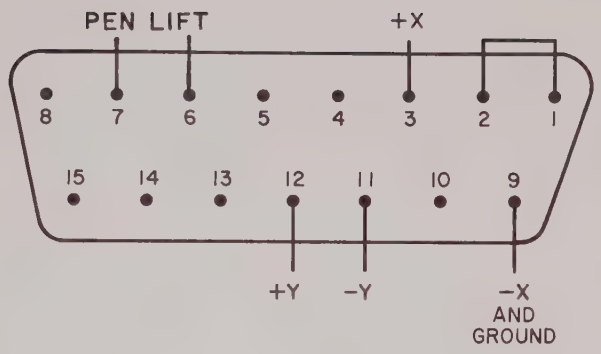


Figure 3.6 X-Y Plotter Control Plug

e) Jumper pins 1 and 2 of remote connector to complete VCO control circuit.

NOTE

If the recorder is of the high input impedance type, connect a 1%, 1.5K ohms resistor between pins 11 and 12 to obtain accurate readings. Note that this resistor is in series with the meter, and that any variation in this resistance will result in inaccurate meter readings. If low impedance recorders or other indicating devices are being connected between pins 11 and 12, the resistance value must be chosen to yield a net resistance of 1.5 K ± 1% ohms between these two pins.

f) Turn instrument power ON.
g) Tune EMC-10 to lowest frequency to be recorded.
h) Adjust recorder X-axis zero adjustment to position pen on left-hand side of paper.
i) Tune EMC-10 to highest frequency to be recorded.
j) Adjust recorder X-axis gain adjustment to position pen at right-hand side of paper.
k) Repeat steps (g) through (i) until both limits are established as required. If recorder does not adjust to zero position on left side because of high voltage being applied representing low frequency end point, a resistor to provide a voltage offset may be required.
m) Position output function selector switch to CAL-TRACKING.

n) Adjust EMC-10 to obtain full-scale meter reading by adjusting to CAL position or applying a signal source. (The Cal-Tracking output may be used here.)
p) Adjust recorder Y-axis gain control until pen is positioned at top of paper.
q) Reduce calibration signal level to obtain -40 dB meter indication.
r) Adjust recorder Y-axis zero adjustment to position pen at bottom of paper, but leave enough space to make use of meter indications between -40 dB and meter zero positions.
s) Repeat steps (n) through (q) until Y-axis limits have been established as required.
t) Proceed with measurements.

3.14.9 AUTOMATIC SCANNING (REMOTE). Since the design of the instrument incorporates a voltage-controlled local oscillator (VCO), it is possible to automatically scan a predetermined section of the instrument's operating range from a remote location. Electro-Metrics Electro-Scan Control Unit Model ESC-10 has been designed specifically for this purpose. Detailed instructions on its use are included in its operating manual.

3.14.10 AUTOMATIC SCANNING (INTERNAL). The EMC-10E version of the instrument contains integral electronic scanning circuitry. To operate in this mode, proceed as follows.

a) Amplitude calibrate in + peak detector switch position.
b) Connect external X-Y recorder as specified in steps (a) through (d) of paragraph 3.14.8.
c) Tune EMC-10E to lowest frequency to be scanned.
d) Using recorder X-axis zero adjustment, set left-hand pen position.
e) Tune instrument to highest frequency to be scanned.
f) Using recorder X-axis gain adjustment, set right-hand pen position.
g) Repeat steps (c) through (f) as necessary until desired X-axis limits have been established.
h) Tune instrument to lowest frequency to be scanned.
i) Turn AUTO SCAN ON. (See Figure 3.3.)
j) Depress and release START switch.

NOTE

When scanning part of the instrument's operating spectrum, the X-Y recorder must have an offset voltage equal to the voltage output at the low end of the spectrum to be scanned. In some recorders the amount of offset voltage available is a function of the range at which the recorder is used, and may not be sufficient for a particular frequency sector. To compensate, an offset voltage potentiometer is included in the instrument's circuitry and controlled from the front panel (see Figure 3.3). When a recorder of this type is used, include the following procedures between steps (b) through (e) of paragraph 3.14.10.

1) Set the recorder zero adjust control to mid-range.

2) Turn AUTO SCAN switch off.

3) Tune EMC-10E to lowest frequency to be scanned.

4) Adjust offset voltage control to position pen at zero line on left-hand side of graph paper.

3.15 PERFORMANCE CHECK-OUT

3.15.1 GENERAL. These Performance Tests are designed to give specific information as to the operational status of the instrument. The results of these tests will indicate whether repair is necessary and whether the EMC-10 is performing within specification limits. The results of these tests as an incoming inspection check should be recorded and used as a standard for testing at every maintenance interval.

3.15.2 WHEN TO TEST. The Performance Tests should be used as part of the incoming inspection check (with the results permanently recorded) and periodically as a part of the maintenance check for every 2000 hours of use.

3.15.3 PERFORMANCE TESTS

a) FREQUENCY CALIBRATION

1) Set the controls as follows:

GAIN . . . . . fully CCW
WIDEBAND RANGE . . . . . .1 mV
SELECTIVE RANGE . . . . .100 uV
IMPEDANCE . . . . . 50 Ω
FILTER . . . . . .500 kHz
BANDWIDTH . . . . . 5 Hz
ΔF 0
ZERO . . . . . .Mechanical Center
FREQUENCY 00000
FUNCTION SELECTOR
OUTPUT . . . . .CAL-TRACKING
LEVEL . . . . . fully CW
DETECTOR FUNCTION.CARRIER
AUDIO . . . . . fully CCW

2) Connect a frequency counter and an oscilloscope to the OUTPUT jack.
3) Adjust the ZERO set control to obtain a zero beat on the oscilloscope.
4) Read the frequency from the frequency counter for the dial setting indicated on the EMC-10 digital frequency indicator.

EMC-10	Frequency Counter	
Digital frequency indicator	Minimum limit	Maximum limit
0 Hz	0 Hz	0 Hz
50 Hz	45 Hz	55 Hz
200 Hz	194 Hz	206 Hz
500 Hz	493 Hz	507 Hz
1 kHz	990 Hz	1010 Hz
2 kHz	1.985 kHz	2.015 kHz
5 kHz	4.970 kHz	5.030 kHz
10 kHz	9.945 kHz	10.055 kHz
20 kHz	19.895 kHz	20.105 kHz
50 kHz	49.745 kHz	50.255 kHz

b) AMPLITUDE CALIBRATION CHECK

1) Set the control as follows:

GAIN . . . . . fully CCW
WB RANGE. . . . . CAL
SELECTIVE RANGE. . . . . CAL
IMPEDANCE . . . . . 50 Ω
FILTER . . . . . .500 kHz
BANDWIDTH. . . . . .WB
ΔF. 0
ZERO. . . . . .Mechanical Center
FREQUENCY. . . . . 20 kHz
FUNCTION SELECTOR
OUTPUT. . . . . .CAL-TRACKING
LEVEL. . . . . fully CCW
DETECTOR FUNCTION . . . . . RMS
AUDIO . . . . . fully CCW

2) Adjust the GAIN control for a full scale reading.
3) Change the BANDWIDTH switch to ~~2500~~, 250, 50 and ~~5~~. The meter should read full scale within ±0.5 dB.

c) ATTENUATOR CHECK

1) Set the controls as follows:

GAIN . . . . . As required for amplitude calibration.
WIDEBAND RANGE 10V
SELECTIVE RANGE. 10V
IMPEDANCE . . . . . .600 ohms
FILTER . . . . . .500 kHz
BANDWIDTH. . . . . .WB
ΔF. 0
ZERO . . . . . .Mechanical Center
FREQUENCY. . . . . .20 kHz
FUNCTION SELECTOR
OUTPUT. . . . . IF-VIDEO
LEVEL. . . . . fully CCW
DETECTOR FUNCTION. . . . . RMS
AUDIO . . . . . fully CCW

2) Apply a 20 kHz signal from a signal generator through a standard 600 Ω, step attenuator with 20 dB steps (0-100), to the input terminal and terminate it in 600 Ω.
3) Set the attenuator at 0 dB and the signal generator to obtain a full scale reading. Increase the attenuator in 20 dB steps and change the WB RANGE switch accordingly to maintain approximately full scale reading. Meter should not deviate beyond ±0.5 dB.

input (RMS)	Meter Deviation from full scale
10V	±0.5 dB
1V	±0.5 dB
100 mV	±0.5 dB
10 mV	±0.5 dB
1 mV	±0.5 dB
100 uV	±0.5 dB

NOTE: Attenuator inaccuracies should be taken into consideration.

4) Repeat the procedure at 50 or 5 Hz bandwidths.

d) IF REJECTION

1) Set the controls as follows:

GAIN . . . . . As required for amplitude calibration
WB RANGE. . . . . 1 mV
SELECTIVE RANGE . . . . . 10 uV
IMPEDANCE . . . . . 10K Ω
FILTER . . . . . .500 kHz
BANDWIDTH. . . . . 5 Hz
ΔF. 0
ZERO. . . . . .Mechanical Center
FREQUENCY. . . . . .36 kHz
FUNCTION SELECTOR
OUTPUT. . . . . IF-VIDEO
LEVEL . . . . . fully CCW
DETECTOR FUNCTION .CARRIER
AUDIO . . . . . fully CCW

2) Connect a 100 kHz source through a 10K resistor to the input.
3) Set the source level to supply 100 mV, RMS at the input. Adjust the source frequency for maximum meter indication. The meter should read less than full scale. IF rejection is better than 80 dB with 50 kHz filter.

e) SPURIOUS RESPONSE

1) Set the controls as follows:

GAIN . . . . . Amplitude Calibration
WB RANGE . . . . . .1 mV
SELECTIVE RANGE . . . . . .0. 1 uV
IMPEDANCE . . . . . 600 Ω
FILTER . . . . . 20 kHz
BANDWIDTH . . . . . 5 Hz
ΔF 0
ZERO . . . . . Mechanical Center
FREQUENCY . . . . . .36 kHz
FUNCTION SELECTOR
OUTPUT . . . . . IF-VIDEO
LEVEL . . . . . fully CCW
DETECTOR FUNCTION . . .CARRIER
AUDIO . . . . . fully CCW

2) Connect a 18 kHz, RMS 1 mV source to the input to obtain a peak on the EMC-10 meter. The meter should read less than full scale. Spurious rejection is greater than 80 dB.

f) BANDWIDTH CHECK for SELECTIVE BANDWIDTH

1) Set the controls as follows:

GAIN . . . . . Amplitude Calibration
WB RANGE . . . . . 1 mV
SELECTIVE RANGE . . . . . 1 mV
IMPEDANCE . . . . . 600 Ω
FILTER . . . . . 500 kHz
BANDWIDTH . . . . . 5 Hz
ΔF 0
ZERO . . . . . Mechanical Center
FREQUENCY . . . . . 20 kHz
FREQUENCY SELECTOR
OUTPUT . . . . . IF-VIDEO
LEVEL . . . . . fully CCW
DETECTOR FUNCTION . CARRIER
AUDIO . . . . . fully CCW

2) Connect a 20 kHz, 1 mV, RMS signal source to the input, and monitor the IF-VIDEO output with a counter.
3) Adjust the EMC-10 frequency control above and below 20 kHz until the meter drops 3 dB from full scale. Record the readings on the frequency counter for each 3 dB drop in the meter.
4) Subtract the lower reading from the higher reading to obtain the bandwidth.
5) Repeat the procedure for all bandwidths, 50, 250, and 2500.

BANDWIDTH	Min.	Max.
5 Hz	4 Hz	6 Hz
50 Hz	45 Hz	55 Hz
250 Hz	225 Hz	275 Hz
2500 Hz	2250 Hz	2750 Hz

NOTE: Only 3 Bandwidths are available on any one instrument.

g) WIDEBAND FREQUENCY RESPONSE CHECK

1) Set the controls as follows:

GAIN . . . . . Amplitude Calibration
IMPEDANCE . . . . . 10 K
BANDWIDTH . . . . . WIDEBAND
WB RANGE . . . . . .1 mV
FILTER . . . . . .500 kHz
FUNCTION SELECTOR
OUTPUT . . . . . IF-VIDEO
LEVEL . . . . . fully CCW
DETECTOR FUNCTION . . . . RMS
AUDIO . . . . . fully CCW

2) Connect a 20 kHz, 1 mV, RMS signal source to the input. Adjust the GAIN control for a full-scale reference.
3) Scan the source from 20 Hz to 500 kHz (change EMC-10 frequency from 20 Hz to 500 kHz). Note the EMC-10 frequency and meter reading as the meter deviates from full scale.
4) Meter deviation at 20 Hz and 500 kHz should not exceed -3 dB and meter deviation between 20 Hz and 500 kHz should not exceed 3 dB.

h) TANGENTIAL SENSITIVITY

1) Set the controls as follows:

GAIN . . . . . Amplitude Calibration
WB RANGE . . . . . .1 mV
SELECTIVE RANGE . . . . . .0. 1 uV
FILTER . . . . . .50 kHz
ΔF 0
ZERO . . . . . .Mechanical Center
FREQUENCY . . . . . .20 kHz
FUNCTION SELECTOR
OUTPUT . . . . . IF-VIDEO
LEVEL . . . . . fully CCW
DETECTOR FUNCTION . .CARRIER
AUDIO . . . . . fully CCW
IMPEDANCE and
BANDWIDTH . . . . . as follows

2) Connect a 20 kHz, 1 mV, RMS signal source to the EMC-10 input. Adjust the GAIN for full scale at each BANDWIDTH AND IMPEDANCE. Disconnect the

source and note the meter reading. Tangential sensitivity is equal to the noise, therefore record each meter reading.

5 Hz BW

IMPEDANCE	NOISE
50 Ω	.006 ± .001 uV
600 Ω	.010 ± .003 uV
10K	.040 ± .010 uV
100K	.100 ± .030 uV

50 Hz BW

IMPEDANCE	NOISE
50 Ω	.010 ± .003 uV
600 Ω	.030 ± .01 uV
10K	.120 ± .04 uV
100K	.300 ± 0.1 uV

250 Hz BW

IMPEDANCE	NOISE
50 Ω	.022 ± .006 uV
600 Ω	.070 ± .02 uV
10K	.280 ± 0.1 uV
100K	.700 ± 0.3 uV

2500 Hz BW

IMPEDANCE	NOISE
50 Ω	.070 ± .02 uV
600 Ω	.220 ± .06 uV
10K	.890 ± 0.2 uV
100K	2.20 ± 0.6 uV

i) LOW PASS FILTER AND SUPRIOUS RESPONSE CHECK

1) Set the controls as follows:

GAIN . . . . . Amplitude Calibration
WB RANGE . . . . . .100 uV
SELECTIVE RANGE. . . . . .100 uV
IMPEDANCE. 10K
FILTER . . . . . 20 kHz
BANDWIDTH. . . . . .WIDEBAND
FUNCTION SELECTOR
OUTPUT. . . . . IF-VIDEO
LEVEL. . . . . fully CCW
DETECTOR FUNCTION . . . . RMS
AUDIO . . . . . fully CCW

2) Connect a signal generator with constant output and a standard attenuator (0-100 dB) through a 10K resistor to the input. At any frequency below 15 kHz, adjust the GAIN control for a full scale reading. Sweep the frequency of the generator from 100 Hz to 100 kHz and note the meter deviation while sweeping from 100 Hz to 15 kHz. Deviation should not exceed ±0.5 dB from full scale.

3) Note the frequency when the meter reading drops 3 dB from full scale. This frequency should not be less than 18 kHz or more than 22 kHz.

4) Tune the frequency generator to 100 kHz. The meter reading should be 40 dB less than full scale or better.

5) Sweep the frequency generator from 100 kHz to 500 kHz, the meter reading should remain 40 dB less than full scale or better.

6) Change the FILTER to 50 kHz and sweep the frequency generator from 100 Hz to 100 kHz, and note the meter deviation when sweeping 100 Hz to 45 kHz. Deviation should not exceed ±0.5 dB from full scale.

7) Note the frequency when the meter reading drops 3 dB from full scale. This frequency should not be less than 48 kHz or more than 58 kHz.

8) Tune the frequency generator to 100 kHz, the meter should be at least 40 dB less than full scale or better.

9) Sweep the frequency generator from 100 kHz to 500 kHz, the meter reading should remain at least 40 dB less than full scale or better.

j) METER FUNCTION CHECK

1) Set the controls as follows:

GAIN . . . . . Amplitude Calibration
WB RANGE. 1V
SELECTIVE RANGE 1V
IMPEDANCE. . . . . 600 Ω
FILTER . . . . . .500 kHz
BANDWIDTH. . . . . .WB
FUNCTION SELECTOR
OUTPUT. . . . . IF-VIDEO
LEVEL. . . . . fully CCW
DETECTOR FUNCTION . . . . RMS
AUDIO . . . . . fully CCW

2) Connect a signal generator through a variable attenuator to the EMC-10 input. Adjust the generator output for a full scale reading at 20 Hz.

3) Check the meter linearity by increasing the attenuator in 10 dB steps and noting the meter response. Maximum deviation at -10 dB, -20 dB, -30 dB, and -40 dB is ±0.5 dB.

4) Adjust the generator for 20 kHz, the EMC-10 meter for -10 dB and change the DETECTOR FUNCTION switch to CAR-

RIER. The EMC-10 meter should not change.
5) Change the DETECTOR FUNCTION switch to QUASI PEAK, + PEAK and - PEAK and note a 3 dB ±.25 change in the meter reading.
6) Change the BANDWIDTH to 5 or 50 Hz and repeat steps 4 and 5.
7) Change the DETECTOR FUNCTION switch to + PEAK, change to WIDEBAND and follow the procedure for SLIDEBACK operation. (3.8.7)
8) Note the meter range when tuning the AUDIO/SLIDEBACK from fully CCW to fully CW. This range must be 25 dB minimum.
9) When the true peak value is obtained (procedure 3.8.7) return the EMC-10 to the normal position, the meter reading should not deviate more than ±2 dB.
10) Repeat steps 7, 8, and 9 for - PEAK.

k) FUNCTION SELECTOR OUTPUT CHECK

1) Set the control as follows:

GAIN . . . . . Amplitude Calibration
WB RANGE 1V
SELECTIVE RANGE. 1V
IMPEDANCE. 10K
FILTER . . . . . .50 kHz
BANDWIDTH. . . . . 50 or 50 Hz
ΔF 0
ZERO. . . . . .Mechanical Center
FREQUENCY. . . . . 20 Hz - 50 kHz
FUNCTION SELECTOR
OUTPUT. . . . . .CAL - TRACKING
LEVEL. . . . . fully CCW
DETECTOR FUNCTION. . . . . RMS
AUDIO . . . . . fully CCW

2) Connect an oscilloscope, (Ballantine) video voltmeter, and a 600 Ω load to the OUTPUT jack. Sweep the frequency of the EMC-10 from 20 Hz to 50 kHz.
3) Note that the output should not deviate beyond ±0.5 dB and P-P voltage is 1.5V before clipping.
4) Change the FUNCTION SELECTOR OUTPUT to RESTORED and apply a 1V RMS, 1 kHz signal to the input connector.
5) Peak the tuning control and note that the output should be 2.8 ± 1.30V P-P.
6) Change the FUNCTION SELECTOR OUTPUT to IF-VIDEO and repeat steps 4 and 5.
7) Change the LEVEL control to fully CCW and note that the DC voltage at the output jack should not exceed ±.05V.

l) AUDIO CHECK

1) Set the controls as follows:

GAIN . . . . . Amplitude Calibration
WB RANGE 1V
SELECTIVE RANGE. 1V
IMPEDANCE 10K
FILTER . . . . . .50 kHz
BANDWIDTH. . . . . 5 or 50 kHz
ΔF. 0
ZERO. . . . . .Mechanical Center
FREQUENCY. . . . . 1 kHz
FUNCTION SELECTOR
OUTPUT. . . . . .CAL-TRACKING
LEVEL. . . . . fully CCW
DETECTOR FUNCTION . . . . RMS
AUDIO . . . . . .fully CCW

2) Connect an oscilloscope and an attenuator across 600 Ω, 5% resistive load connected to the Phone jack and set the tuning dial to 1 kHz and apply a 1 kHz signal from a signal generator.
3) Advance the AUDIO control until distortion starts to occur on the scope trace, then back off until the trace appears clean and record this output level.
4) This level should be 22.5 ± 10V P-P.
5) Sweep the EMC-10 FREQUENCY control and note the points where the audio response is 3 dB down.
6) The low end should be less than 100 Hz and the high end should be not less than 10 kHz or more than 16 kHz.
7) Change the FUNCTION SELECTOR OUTPUT switch to BFO and peak the tuning on the 1 kHz signal. Connect a counter to the OUTPUT jack and record the beat frequency. The beat should be not less than 300 Hz and not more than 2000 Hz.

m) AUTO SCAN (E Models Only)

1) Set the controls as follows:

GAIN. . . . . Amplitude Calibration
WB RANGE. 1V
SELECTIVE RANGE 1V
IMPEDANCE. 10K
FILTER . . . . . .500 kHz
BANDWIDTH. . . . . 2500 or 250 Hz
ΔF. 0
ZERO. . . . . .Mechanical Center
FREQUENCY. 0
FUNCTION SELECTOR
OUTPUT. . . . . .CAL-TRACKING
DETECTOR FUNCTION. . . . . RMS
AUDIO . . . . . fully CCW

2) Connect a frequency counter to the OUTPUT jack and set the LEVEL con-

trol to obtain a count on the frequency counter.

3) Turn the AUTO SCAN switch ON and depress the AUTO START button. Record the readings from the counter for the starting and stopping points and the scan time.

4) The starting point should be approximately 20 Hz and the stopping point should be approximately 50 kHz. The SCAN time should be for the 2500 Hz BW, 50 ±20 sec; 250 Hz BW, 50 ±20 sec; 50 Hz BW, 5 ±1 min; and 5 Hz BW, 50 min ±10 min.

SECTION IV
SERVICE AND MAINTENANCE

4.1 GENERAL

4.1.1 This section includes material necessary for the proper calibration, maintenance, and repair of the EMC-10. If the following procedures are adhered to, the instrument will provide years of accurate, reliable service. However, failure to follow these procedures could violate the terms of the manufacturer's warranty, in addition to limiting the reliability of the instrument.

4.1.2 This instrument contains a nickel-cadmium battery which, when fully charged, can power the instrument without connection to an external AC or DC supply for up to eight hours. It will fully recharge after such usage in sixteen hours.

Because most testing with this instrument is usually performed sporadically for short periods of time, it is difficult to know the charge condition of the battery. The front panel Battery Test Switch indicates only relative charge condition of the battery, it does not indicate exact degree of charge or balance condition of the battery or of voltage to the instrument.

Operation of all circuits in this instrument is highly dependent on the regulation of the +12 volt and -12 volt power supply. Before performing any service or calibration of the instrument consult Section 4.3.2, Power Supply.

4.1.3 For most efficient operation this instrument should be connected to a live outlet, whether turned OFF or ON, as the normal condition of usage, and kept on charge even when in storage. It cannot be overcharged.

The internal battery should be used when the instrument is fully disconnected from the power line, when in the field, or at other appropriate times. Normally the instrument should be kept on AC and as near full charge at all times for best overall operation.

4.2 INSTRUMENT ACCESS

4.2.1 To gain access to the interior of the instrument, the outside case is taken off by removing two screws near the front edge on the left and right sides of the case. Also remove four screws from the bottom face. The instrument will slide easily from the case. (Do not remove screws which hold rubber feet.)

4.2.2 To gain access to the battery-operated power supply (A5), it is not necessary to remove the outside case; simply loosen the four "Twist Lock" fasteners in the rear access panel (see Figure 4.1) and remove the panel.

4.2.3 The service calibrations can be performed without removing the inside covers by using the calibration access holes (see Figures 4.2 and 4.3). In order to repair or replace the components in sub-assemblies A4 and A3, the covers must be removed. To gain access to sub-assembly A4, remove four screws in the rear cover face (see Figure 4.3) and slide off the cover.

To gain access to sub-assembly A3, remove the top and bottom plates, each of which is secured by 18 screws (see Figure 4.2). Also remove ground wire connection from bottom plate.

4.3 PERIODIC SERVICE CALIBRATIONS

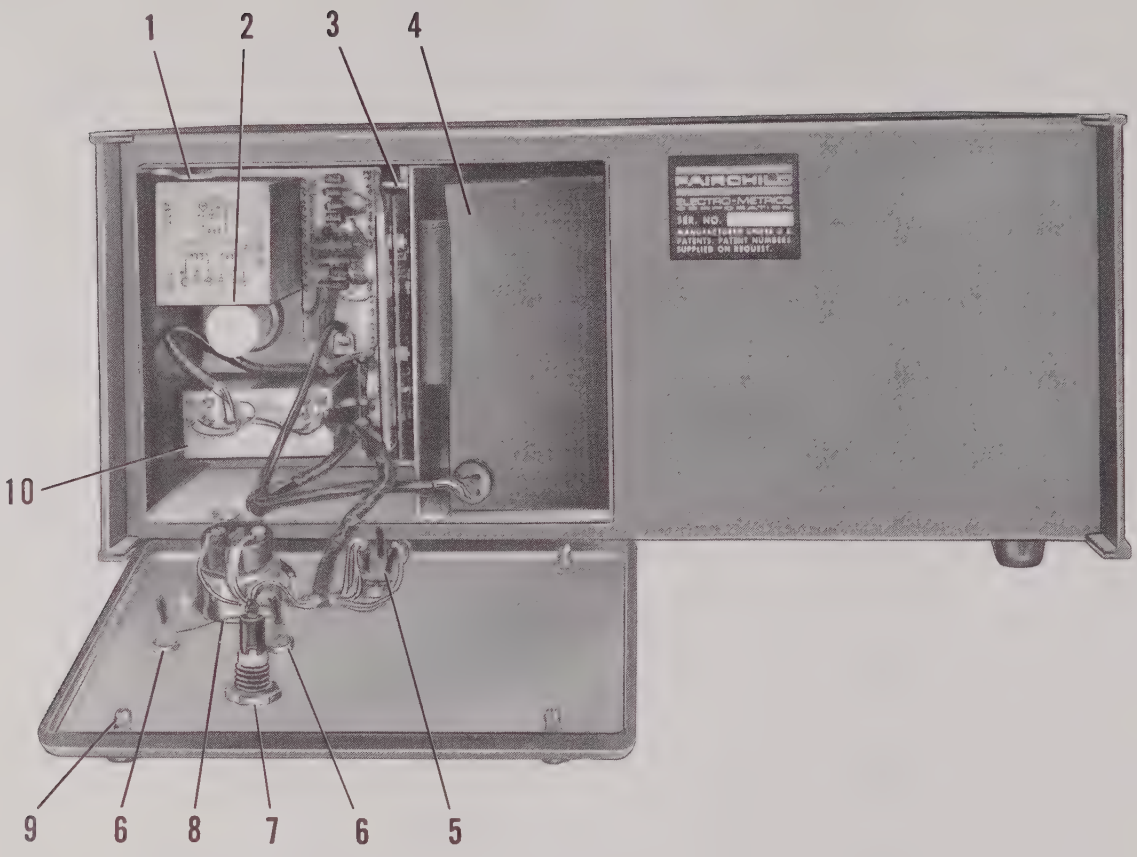
4.3.1 The following calibrations should be performed on a regular service schedule when the instrument is used for nominal measurements.

4.3.2 POWER SUPPLY. Proper power supply operation is vital to all circuit functions. All service as well as periodic calibration should begin with a check of both battery and regulated voltages. Access to the power supply is described in paragraph 4.2.2.

A5FL1 (Figure 4.1), visible from the rear of the EMC-10 when the power supply compartment is opened has terminals that may be used for measurement of these voltages. At these terminals and throughout the instrument the following color code is utilized:

Orange	=	plus "raw" voltage
Gray	=	minus "raw" voltage
Red	=	plus 12 volts
White	=	minus 12 volts

It is recommended that the instrument be turned off and connected to a live AC power line for at least 16 hours prior to servicing to fully charge the battery. At the conclusion of the charge cycle with the instrument ON but not connected to the AC line, at least 17.5 volts should appear on the "raw" busses. A lower



1. Transformer, power A5T1
2. Capacitor A5C1
3. Voltage regulator printed circuit A5P5
4. Battery (BAT-10)
5. 110-220 Changeover switch
6. External battery connection (Red + Gray -)
7. Main power fuse A5F1
8. External power supply connector
9. "Twist-Lock" fastener (4)
10. Power filter A5FL1

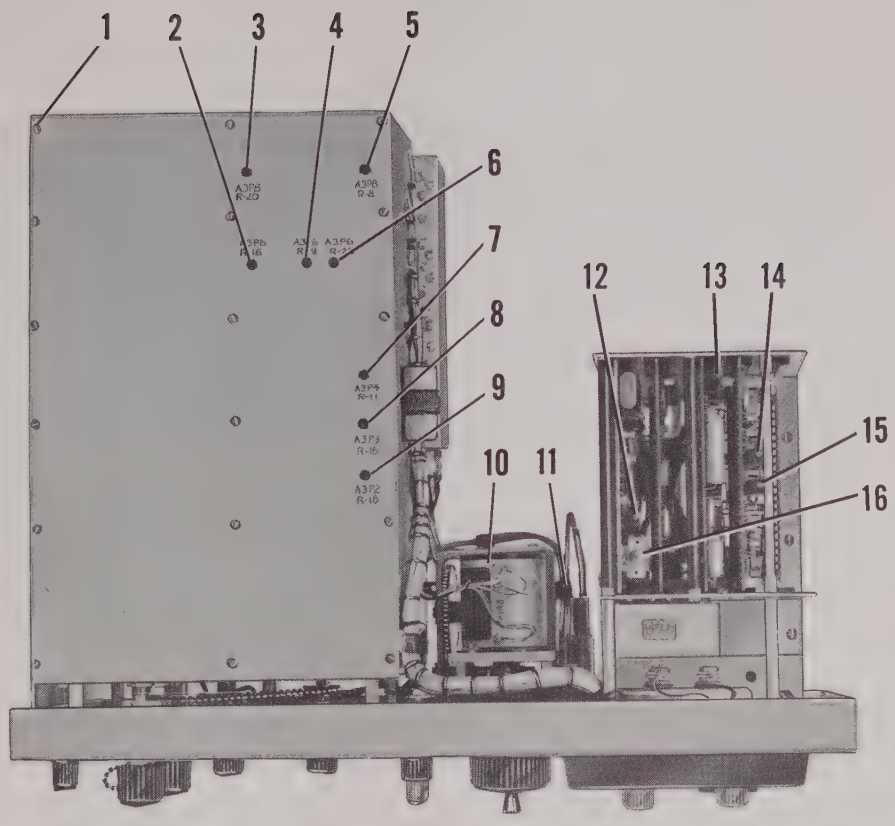
Figure 4.1 EMC-10 Case Rear View

voltage indicates either a defective battery, short circuit, or malfunctioning charger. Charger operation may be checked by plugging the instrument into a live AC line and noting that the "raw" voltage slowly rises. It can rise as high as 22.5 volts following a long charge with the instrument turned off. The "battery test" mark on the meter indicates 30 volts total "raw" battery voltage.

Before checking or adjusting either regulated supply, its "raw" buss should read at least 14 volts. Voltage adjustment potentiometers A5R7 and A5R18 (Figure 7.7) are set so the red and white lead terminals on A5FL1 read plus and minus 12 volts within 50 millivolts. Later model instruments have the potentiometers replaced by precision resistors, selected to complement the voltages of the reference diodes A5CR2 and A5CR4. In these instruments regulated voltages will normally read between 11.9 volts and 12.1 volts at A5FL1.

4.3.3 EMC-10E SWEEP CIRCUIT. The three adjustments of the sweep circuit (A3P9) are factory set to compensate for component variations. Resistor R14 is adjusted only if Q1 or Q2 is replaced. Resistor R18, the sweep rate control, will need adjustment only if A1C is changed or if an abnormal sweep rate is desired. The normal sweep rate is 1 KHz per second for 250 Hz bandwidth, 250 Hz per second for 50 Hz bandwidth and 25 Hz per second for 5 Hz bandwidth.

4.3.4 METERING CIRCUIT ALIGNMENT. Alignment procedure for the meter circuits of the Models EMC-10 and EMC-10E Analyzers is as follows.



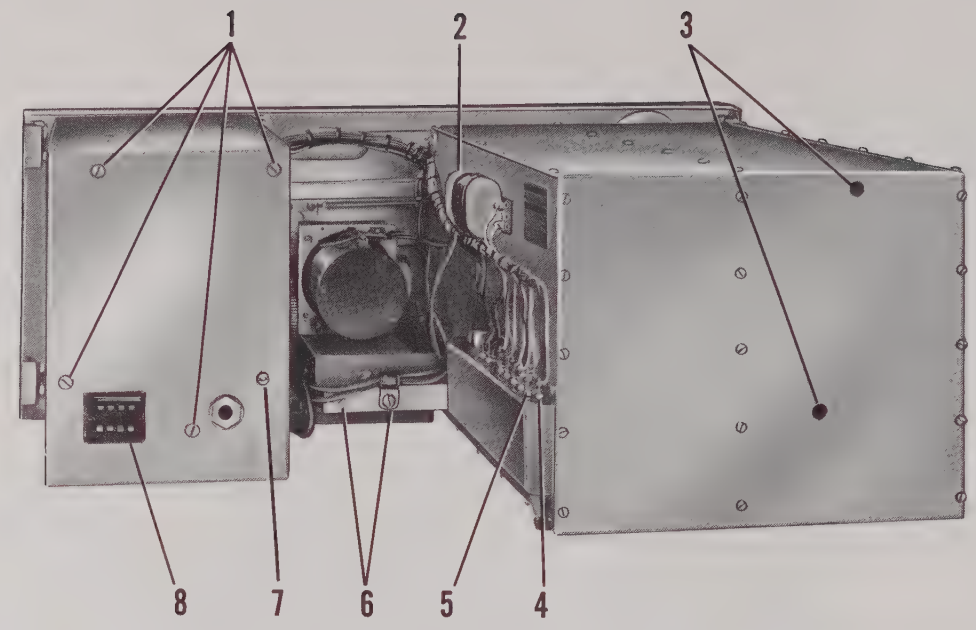
1. Access plate screws (18)
2. Access hole - A3P6 (R16)
3. Access hole - A3P8 (R20)
4. Access hole - A3P6 (R19)
5. Access hole - A3P8 (R8)
6. Access hole - A3P6 (R25)
7. Access hole - A3P4 (R11)
8. Access hole - A3P3 (R16)
9. Access hole - A3P2 (R16)
10. Tuning Potentiometer A1R3
11. Harness Clip
12. A4P7 (R7)
13. A4P5 (R19)
14. A4P4 (R17)
15. A4P4 (R16)
16. A4P7 (C1)

Figure 4.2 EMC-10 Top Access Holes

a) Set controls:

GAIN control . . . . . clockwise
Detector function . . . . . CARRIER
BANDWIDTH control. . . . .WIDE BAND
W. B. RANGE control . . . . . 100 mV
N. B. RANGE control . . . . . 100 mV
FILTER control. . . . . .500 kHz
IMPEDANCE switch . . . . . .50 ohms

b) Apply a 20 kHz, 100 mV signal to the input connector.
c) Adjust the level of the external source with the front panel GAIN control to obtain 75 mV at the input to the LOG AMPLIFIER (pin L, A3J5).
d) Decrease input signal by 20 dB.
e) Adjust R25 on A3P6 to obtain a -20 dB reading on meter scale.
f) Increase input signal level 20 dB and adjust R19 on A3P6 for full scale deflection.
g) Repeat steps d) through f) to obtain meter readings to within ±0. 25 dB.
h) Decrease input signal by 30 dB.
i) Adjust signal level with the front panel GAIN control for a -30 dB reading on the meter scale.
j) Repeat steps d) through i) to achieve agreement.
k) Decrease input signal by 40 dB.
m) Adjust A4P4-R16 to obtain a -40 dB reading on meter scale.
n) Repeat steps d) through m) to achieve ±0. 25 dB meter accuracy.
p) A. Adjust input signal to read -10 dB



1. A4 cover attachment screws
2. Charging capacitor - EMC-10E only
3. Access holes - for crystal filter*
4. White wire stand-off (-12 volts)
5. Red wire stand-off (+12 volts)
6. Gear train bracket attachment screws
7. Access hole - tracking freq. adj. A4C1
8. Power supply connector A4J1

*DO NOT ADJUST

Figure 4.3 EMC-10 Interior Rear View

on the meter. With Detector Function at + Peak Adjust A4P4-R17 for +3 dB reading above Carrier Reference reading.

B. Set detector function to - Peak and note meter reading. If the + and - Peak readings do not agree, adjust A3P6-R16 to equate the two. Re-check meter linearity and repeat steps (a) through (m) if necessary.

q) Set the input signal level to 50 mV, the FUNCTION SELECTOR to CARRIER, and GAIN control fully CW. Adjust the gain of wideband amplifier (A3P4-R11) to obtain a full scale meter deflection.

r) Change BANDWIDTH control to 50 Hz and tune the instrument to peak response at the frequency of the incoming signal.

s) Adjust gain of 2nd IF amplifier (A3P3-R16) to obtain full scale meter deflection.

4.3.5 GAIN - WIDEBAND.

a) After connecting test harness (Fairchild PEC-10) for power, attach external signal generator to INPUT connector of EMC-10.

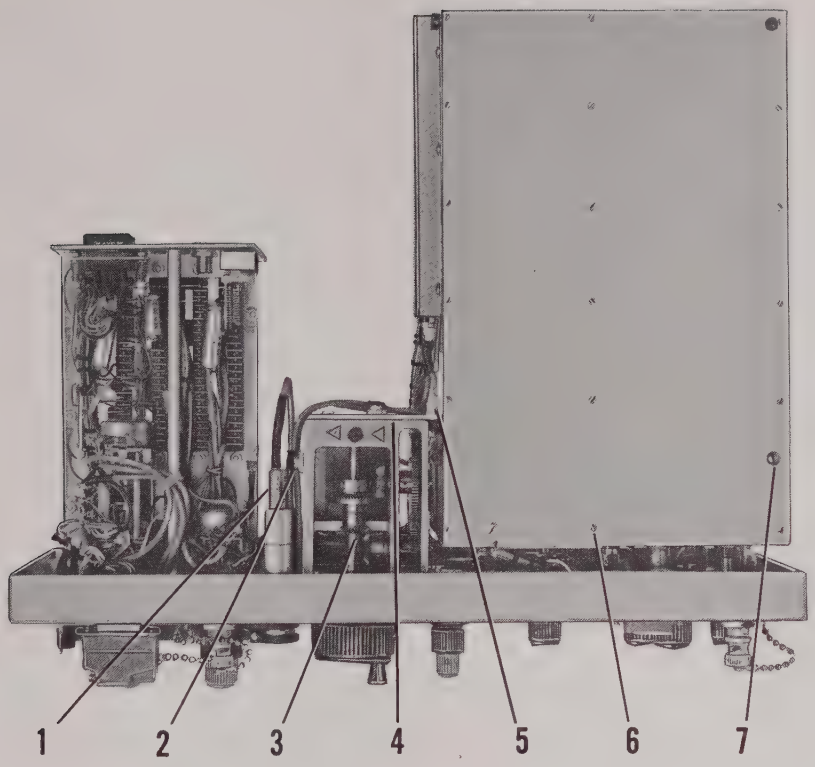
b) Connect external calibrated voltmeter in parallel with EMC-10, using BNC "T" adapter in order to monitor input signal voltage.

c) Turn power ON and provide 30-minute warmup period before proceeding with calibration.

d) Set front panel controls as follows.

GAIN control	Fully clockwise
Detector function	CARRIER
BANDWIDTH control	WIDEBAND
RANGE control	1.0 mV
FILTER control	500 kHz
IMPEDANCE switch	600 ohms

e) Tune signal generator to deliver 0.6 mV signal at approximately 20 kHz, to EMC-10 input.



1. Filter, audio A1FL1
2. Harness clip
3. Gear train assembly
4. Gear train assembly support bracket
5. Gear train bracket screws
6. Access cover screws (18)
7. Main mounting nuts

Figure 4.4 EMC-10 Bottom View With Access Plate On

f) Adjust gain potentiometer A3P4 (R11) until meter reads 1.0 mV.

NOTE

This potentiometer, located on the wideband amplifier printed circuit board (A3P4), may be adjusted through the top cover access hole provided (see Figure 4.2).

4.3.6 IF GAIN - SELECTIVE BAND. After completing the wideband calibration, proceed as follows.

a) Set BANDWIDTH control at 250 Hz, and leave all other controls as set in paragraph 4.3.5.
b) Using input signal employed in paragraph 4.3.5, tune EMC-10 to peak the signal.
c) Adjust IF gain until meter reads full scale.

NOTE

In order to adjust the IF gain, adjust the potentiometers mounted on the first and second IF amplifier printed circuit boards (A3P2 and A3P3). These may be reached through the calibration access holes (see Figure 4.2).

d) After gain has been adjusted to provide 1.0 MV meter reading, check for possible de-tuning by tuning ΔF control to obtain peak meter reading.
e) Repeat with BANDWIDTH switch first in the 50 Hz position and then in the 5 Hz position.
f) Note readings. Readings should be within $\pm$0.5dB of each other. If not, filter is defective and should be returned to factory for repair or replacement.

4.3.7 FREQUENCY ACCURACY ADJUSTMENT. To perform the frequency calibration, proceed as follows.

a) Attach external frequency counter to EMC-10 BNC output connector and set front panel controls as follows:

BANDWIDTH control . . . . . 5 Hz
Frequency . . . . . 00000 Hz
Δ F switch . . . . . 0.0 Hz
Function selector . . . CAL-TRACKING

b) Adjust ZERO control to obtain maximum meter deflection, and note reading on external frequency counter. Reading should be 00000 Hz.
c) If the ZERO control is not near the midpoint at its mechanical range, set ±25 Hz accordingly and adjust A3P8 (R20) for a 0.0 Hz reading on the external frequency counter.
d) Re-tune EMC-10 to obtain 20000 Hz on digital indicator.
e) If external frequency counter does not indicate same frequency, adjust potentiometer A3P8 (R8) located on VCO printed circuit (A3P8) until above frequency is obtained on external counter.

NOTE

Potentiometers A3P8 (R8) and A3P8 (R20) may be adjusted through the cover access holes provided (see Figure 4.2).

f) Repeat procedure with EMC-10 tuned at 40000 Hz and 10000 Hz.
g) At 40,000 Hz, digital readout should be between 39790 Hz and 40210 Hz. At 10,000 Hz, readout should be between 9945 Hz and 10055 Hz.
h) If not, adjust potentiometer A3P8 (R8) with EMC-10 tuned to 0.0 Hz until all above readings fall within specified ranges.

4.3.8 AMPLITUDE CALIBRATOR ADJUSTMENT. In order to check instrument internal calibration, proceed as follows:

a) Position front panel controls as follows:

IMPEDANCE switch . . . . . 600 ohms
FILTER control . . . . . 500 kHz
BANDWIDTH switch . . . . . WIDEBAND
RANGE control . . . . . 1 mV
Function selector . . . . . CAL-TRACKING

b) Apply a 1 mV 20 kHz signal to the input and adjust the GAIN control for full-scale deflection.
c) Reset the WIDEBAND RANGE control to CAL and change the IMPEDANCE control to 50 Ω.
d) Adjust potentiometer A4P7 (R7) until full-scale deflection is obtained on meter.
e) Set the BANDWIDTH control to 250 Hz and change the SELECTIVE RANGE to CAL. Note the meter reading.
f) Repeat with the BANDWIDTH control at 50 and 5 Hz. In all cases the meter should still read full scale.
g) If the meter is not at full scale, adjust capacitor A4C1 (see Figure 4.3) until a full scale indication is obtained.
h) If the 50 and 250 Hz loads do not match the 5 Hz level, the gain potentiometer at the top of the crystal filter, A2FL2 (Figure 2.2) should be adjusted for equal gains.

4.4 TROUBLESHOOTING

4.4.1 The procedure for troubleshooting the EMC-10 is the same as for any other electronic device. It consists of pinpointing the source of malfunction by logically eliminating alternate possibilities. Obviously, eliminating the greatest number of possibilities with any one check will quickly narrow the remaining choices until the defective component or circuit is isolated. For example: If the instrument gives no meter reading or output signal under any of the operating modes, then the defect must be located in one of the common components or circuits. Table 4-1 lists the items that are logically suspect under such a dead-instrument condition. The items are also listed in their operating order. It is a recommended practice to make the first check at the middle of the list. This will automatically eliminate half the possibilities.

If the EMC-10 is only partially defective, the nature of the defect will lead to a limited number of possible malfunctions. Table 4-2 lists the major possible conditions and their possible causes.

With the use of Tables 4-1 and 4-2, the source of trouble within a given circuit can be localized. Since the major circuits are printed circuit boards, the isolation of the individual component is relatively simple.

4.5 PRINTED CIRCUIT BOARD MAINTENANCE

4.5.1 Should a printed circuit board become heavily damaged, or the printed circuit become marred, causing the circuit impedance to change, it is recommended that the entire assembly be re-ordered from the manufacturer. (For assembly order numbers, see Table 6-1.)

CAUTION

Do not remove circuit boards while power is on. Power switch should be in down position.

TABLE 4-1

TROUBLESHOOTING CHECK LIST (MAIN PATH)

CONDITION: No meter reading or output at any function.

STEP	ITEM	LOCATION	PROCEDURE
A	dummy plug	(see Figure 3.1)	check that plug is properly connected
B	battery	power supply	press BAT TEST switch
C	power supply	(see Figure 4.3)	check red stand-off for +12 volts
D	power supply	(see Figure 4.3)	check white stand-off for -12 volts
E	pre-amp. IN	pin A3J1-L	check with scope for signal
F	pre-amp. OUT	pin A3J1-D	check with scope for signal
G	log. amp. IN	pin A3J5-L	check with scope for signal
H	log. amp. OUT	pin A3J5-B	check with scope for signal
I	detector driver IN	pin A3J6-A	check with scope for signal
J	detector driver OUT	pin A3J6-L	check with scope for signal
K	TVM IN	pin A4J4-R	with detector function in CARRIER position check as above
L	TVM OUT	pin A4J4-H	check output with a VTVM

4.5.2 When removing printed circuit boards, use an extractor tool or smooth-faced, non-serrated pliers to avoid damage to the board.

4.5.3 When re-installing printed circuit boards in the EMC-10, snap the board firmly into place. When doing so, apply pressure evenly along the top edge of the board.

4.5.4 Maintain original alignment when replacing components on circuit boards, particularly when adjusting components through special acces holes.

4.5.5 When servicing printed circuit boards, it is required to use alignment circuit board extenders ECB-10A and B.

NOTE

Observe the following precautions when handling printed circuit boards.
a) Never allow the printed side to come into contact with abrasive surfaces or objects. This can cause aberrations in the surface conductivity and create unwanted capacitance.
b) Never touch the printed surface with bare fingers; skin oils can create leakage paths.
c) Avoid excessive heat when repairing a board; this can cause the circuit and board to separate.
d) After repairing a printed circuit, clean the printed surface of all contaminants.
e) To clean, use a weak solution of warm water and mild detergent only.
f) Be sure to clean excess solder and resin from board. Be sure that excess has not created new circuit paths.

4.6 TRANSISTOR REPLACEMENT

4.6.1 The performance of the amplifiers used in the EMC-10 rely on the feedback characteristics of the circuits rather than transistor

TABLE 4-2

TROUBLESHOOTING GUIDE

CONDITION	CHECK COMPONENT OR CIRCUIT
Reading in WIDEBAND only	switches A2S5A and A2S5B filter A2FL2 VCO A3P8 IF amplifiers A3P2 and A3P3
Reading in SELECTIVE only	switches A2S5A and A2S5B
No signal in WIDEBAND position	switch A2S4F wideband amplifier A3P4
No signal at 100 K ohms position	attenuator assembly A2S4C and A2S4D emitter follower A2EF1
No output at BNC connector	video amplifier A4P5
IF output only	mixer board A4P6
No CAL-TRACKING output signal	tracking oscillator A4P7
No AUDIO output	audio amplifier A4P5
No BFO output	BFO oscillator A4P7
Signal at 100 K ohms only	attenuator assembly A2S4A and A2S4B
Transistors in power supply overheating	incorrect power source (instrument connected to 220V when not wired for same)
Reading low at 5 Hz BANDWIDTH when in CAL position	adjust capacitor A4C1 (see Figure 4.3) until CAL signal tracks with VCO

parameters. For this reason, transistors with similar parameters can be used interchangeably without affecting instrument performance. The following list gives the acceptable alternates. The left column lists the transistors supplied in the instrument (Fairchild part numbers). The right column lists the general transistor type commercially available.

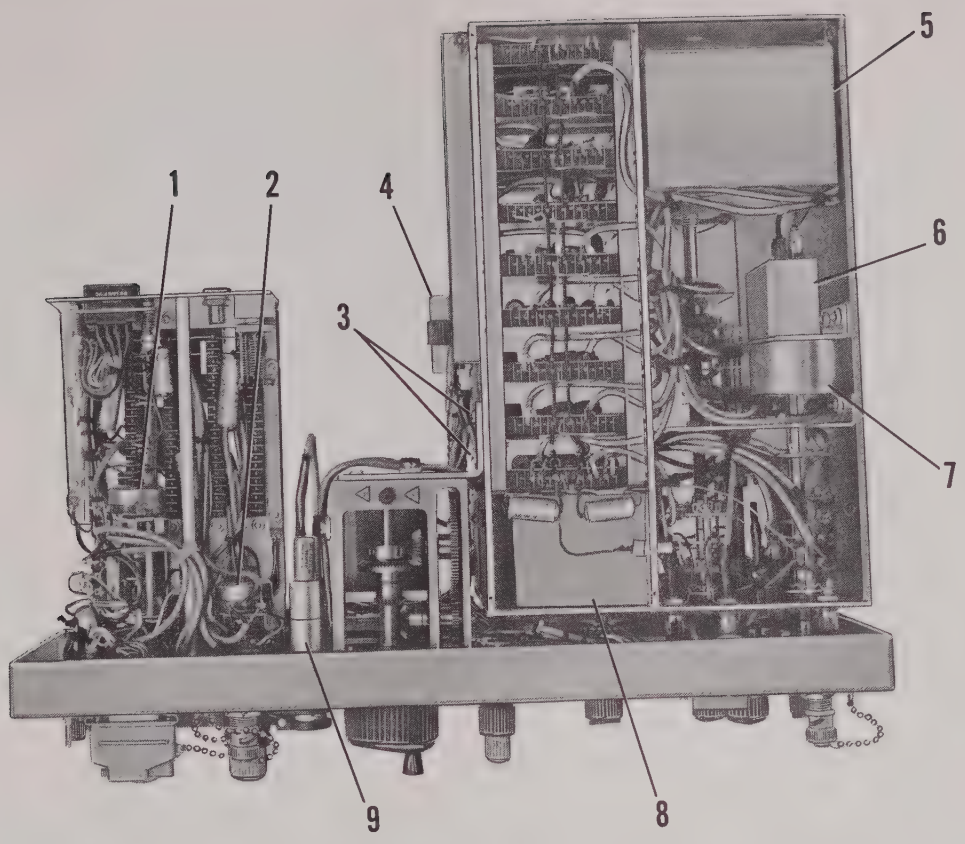
TRANSISTOR	EQUIVALENTS
S3091	2N914
S3092	2N915
S3094	2N2303
S7956	2N1711
S7958	2N3277
S15695	2N3504
S15781/S16659	2N3117
S16660	2N3015
SP9657	2N2920
SP9660	(Fairchild) SP8304

4.7 REPLACEABLE ASSEMBLIES

4.7.1 This paragraph covers the removal and replacement of those assemblies which are not field-repairable but may be removed from the instrument and returned separately to the factory. This will eliminate the necessity of repackaging and shipping the entire instrument.

4.7.2 GEAR TRAIN ASSEMBLY 2251. Should any component of the gear train assembly malfunction, including the tuning potentiometer (see Figure 4.2), the entire assembly should be removed from the instrument and returned to the factory for repair. When doing so, use the following procedure.

a) Remove frequency control knob by taking off the two set screws holding it to the shaft.
b) Remove screws positioned behind frequency control knob in front panel.



1. Audio/slideback pot. A1R1
2. Level potentiometer A1R2
3. Gear train bracket attachment screws
4. Charging capacitor - EMC-10E only
5. Crystal filter A2FL2
6. Balanced modulator A2BM1
7. Impedance matching attenuator
8. 20-50 KHz filter A2FL1
9. Audio filter A1FL1

Figure 4.5 EMC-10 Bottom View - Covers Off

c) Remove harness clip (see Figure 4.2) attached to side of gear train housing.
d) Remove two screws (see Figure 4.5) securing mounting bracket to subassembly A3.
e) Unsolder three wires at potentiometer terminals.

NOTE

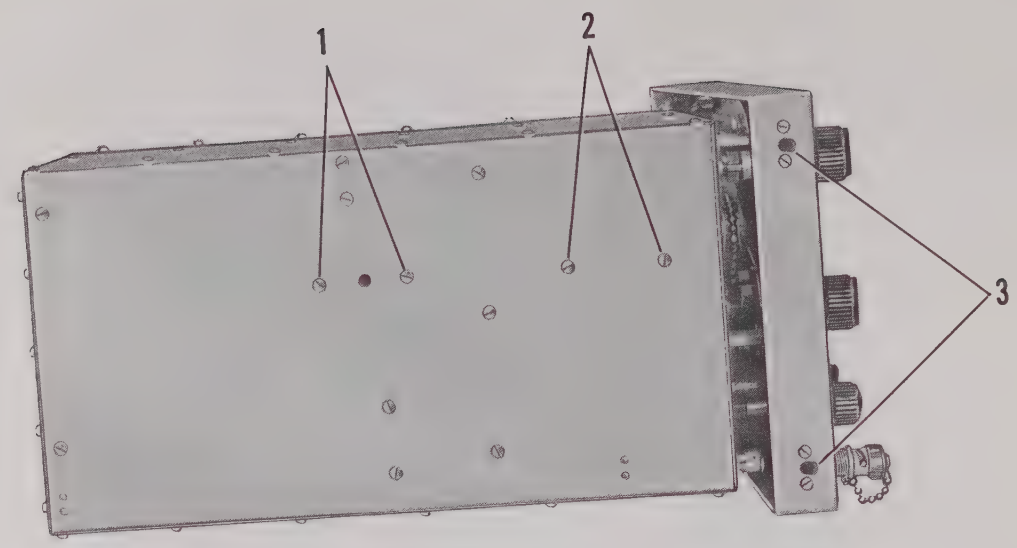
Maintain maximum length on all leads. No extra leads will be supplied with repaired or replacement parts. If additional wiring must be added, use number 22 wire. For ease in future maintenance, use same color wire.

f) Remove gear train assembly; careful not to damage digital frequency counter.
g) Package and ship to factory as specified in paragraph 4.9.

4.7.3 BALANCED MODULATOR A2BM1. Should the balanced modulator (see Figure 4.5) malfunction, the entire incased assembly must be returned to the factory in an unopened condition. To remove the assembly, use the following procedures.

a) Remove outside case and top and bottom access covers of subassembly A3 as specified in paragraph 4.2.

b) Disconnect six phono plugs (see Figure 2.2).



1. Balanced modulator attachment screws.
2. Emitter follower attachment screws
3. Exterior case attachment screw holes

Figure 4.6 EMC-10 Side View

c) Remove two screws (see Figure 4.6) securing modulator to subassembly A3.
d) Remove modulator assembly.
e) Package and ship to factory as specified in paragraph 4.9.

4.7.4 EMITTER FOLLOWER A2EF1. Should the emitter follower malfunction, it must be returned to the factory for repair or replacement. To maintain the terms of the manufacturer's warranty, it must be returned in a sealed and unopened condition. In order to remove the assembly, use the following procedures.

a) Remove outside case and top and bottom covers on subassembly A3, as specified in paragraph 4.2.
b) Unsolder five wires at emitter follower terminals. Note color and location of wires for reassembly.

NOTE

Maintain maximum length on all leads. No extra leads will be supplied with repaired or replacement parts. If additional wiring must be added, use number 22 wire. For ease in future maintenance, use same color wire.

c) Remove two screws attaching emitter follower to subassembly A3 (see Figure 4.6).
d) Remove emitter follower assembly.
e) Package and ship to factory as specified in paragraph 4.9.

4.7.5 GAIN POTENTIOMETER A2R1. Should gain potentiometer A2R1 (see Figure 2.2) malfunction, remove the potentiometer according to the following procedure.

a) Remove outside case and top and bottom covers on subassembly A3, as specified in paragraph 4.2.
b) Loosen two set screws on GAIN control knob and remove knob.
c) Loosen two set screws on shaft coupling (see Figure 2.2).
d) Unscrew shaft lock nut (see Figure 2.2).
e) Unsolder three wires at potentiometer terminals (note position of wires for reassembly).
f) Remove potentiometer.
g) Package and ship to factory as specified in paragraph 4.9.

4.7.6 AUDIO FILTER ASSEMBLY 2170. Audio filter assembly 2170 (see Figure 4.5) incorpor-

ates audio filter A1FL1 and the front panel phone jack. If either of these components malfunctions, the complete assembly must be removed and returned to the factory for repair or replacement. In doing so, use the following procedure.

a) Remove outside case as in paragraph 4.2.
b) Lift phone jack cover (front panel) and unscrew phone jack lock nut.
c) Unsolder one wire at connector on audio filter.

NOTE

Maintain maximum length on all leads. No extra leads will be supplied with repaired or replacement parts. If additional wiring must be added, use number 22 wire. For ease in future maintenance, use same color wire.

d) Remove filter.

NOTE

A ground wire connection is made through a grounding washer which is held to the back face of the front panel by the filter. Be sure that this washer is in place before reassembly.

e) Package and ship to factory as specified in paragraph 4.9.

4.8 220-VOLT INSTRUCTIONS

4.8.1 The EMC-10 is normally wired for 115 volt AC operation. For 220-volt operation adjust the switch on the rear power supply cover to the 220 V position with screwdriver or other tool.

4.9 PACKAGING FOR SHIPMENT

4.9.1 Should it become necessary to return the instrument, a component, or an accessory to the factory for repair or replacement, package in accordance with the following procedure.

a) Repackage in original shipping carton if available.
b) If original container is not available, package in cardboard carton, cushioning all sides with a resilient material. Pack material firmly around the instrument to prevent motion.
c) Seal cardboard container with cloth shipping tape.
d) Package sealed cardboard container in a securely fitted wood slat crate.
e) Wire tie crate with approved crating wire and mark "FRAGILE" on all sides.
f) Enclose packing slip for every item shipped.

NOTE

Before packaging instrument, on company stationery, list the serial number of the instrument, the nature of the malfunction, and the name of an individual whom the manufacturer can contact for additional information. PLEASE INCLUDE RETURN SHIPPING ADDRESS.

NOTE

In the case of small components or accessories, it is not necessary to package in a wood crate.

SECTION V
ACCESSORY DATA

5.1 GENERAL

5.1.1 This section contains information describing available accessory items designed specifically for operation with the EMC-10 Interference Analyzer. All of these are listed in Table 5-1. Those items requiring further description are discussed in the following paragraphs.

5.2 ELECTRO-SCAN CONTROL UNIT ESC-10

5.2.1 DESCRIPTION. The ESC-10 is designed to extend the functions of the EMC-10 by providing local or remote automatic frequency scanning and control. It also adds the same dimension of remote operation to the Model EMC-10E.

The sweep voltage circuitry of the unit provides a choice of three sweep rates for electronically tuning the interference analyzer. These rates correspond to the selective mode bandwidth that are being utilized. When scanning the full 20 Hz to 50 kHz frequency range, sweep durations of one minute, five minutes, and fifty minutes are employed, corresponding to bandwidths 250 Hz, 50 Hz, and 5 Hz, respectively. Any portion of the EMC-10 frequency range may be swept by adjustment of High and Low Limit dials.

All operating power is fed to the unit from the Interference Analyzer. The ESC-10 supplies a constant ramp voltage of 1.5 volts for automatically scanning the X-Y plotter. Connections for these are available on the ESC-10 front panel (see Figure 5.1). Packaging of the ESC-10 conforms to the universal half rack configuration, 5-inches high for maximum ease of handling and mounting.

Figure 5.1 Electro-Scan Control Unit Model ESC-10

5.3 CAPACITIVE ANTENNA PEF-10 (Figure 5.2)

5.3.1 DESCRIPTION. This unit is designed for making electric field measurements when used with the EMC-10 series interference analyzers. The probe is a half-meter capacitive dipole connected to a very high impedance differential amplifier. The amplifier contains Fairchild Semiconductor field effect transistors feeding a linear integrated circuit, all incorporated directly in the antenna assembly. The low impedance output of this solid state amplifier is fed to the Interference Analyzer through the 25-foot multiple conductor cable. The Interference Analyzer supplies all operating voltages and calibration signals to the unit.

5.3.2 INSTALLATION. For operation, install the TMT-10 Mount unit on Tripod TRI-10. On this, mount the antenna and connect the 25-foot multiple conductor cable to the PROBE INPUT connector on the front panel of the Interference Analyzer.

TABLE 5-1

ACCESSORY LIST

ITEM	DESCRIPTION	MODEL
1.	X-Y Recorder with interconnecting cable Model XYC-10	EXY-125
2.	Instrument Carrying Case (for EMC-10)	ICC-10
3.	Capacitive Antenna Assembly (Electro-static Field Probe) complete with dipole, 25-foot cable and Tripod Mount Model TMT-10	PEF-10
4.	Loop Antenna, 25-inch	ALP-10
5.	Coaxial Cable, 25-foot	CAC-10
6.	Clamp-on Probe	PCL-10
7.	Loop Accessory Case	LAC-10
8.	Earphones, speech	EEM-10
9.	Earphones, high intelligibility	EHF-10
10.	Remote Meter with 20-foot cable	RIM-10
11.	Accessory Carrying Cover	EAC-10
12.	Tripod	TRI-10
13.	Tripod Bag	TRB-10
14.	Tripod, extra rugged, with bag	TRR-10
15.	Adapter Brackets for 19-inch Mounting	ABM-10
16.	Electro-Scan Control Unit	ESC-10
17.	Extra AC Power Cable	PCD-10
18.	Extra X-Y Recorder shielded interconnecting cable to EMC-10	XYC-10
19.	Replacement Battery Pack, Nickel Cadmium	BAT-10
20.	Alignment Power Extension Cable	PEC-10
21.	Alignment Extension Circuit Board, 12 pin	ECB-10A
22.	Alignment Extension Circuit Board, 22 pin	ECB-10B
23.	Clamp-On Probe Amplifier	PCA-10
24.	60 Hz Notch Rejection Filter	NRF-10

Figure 5.2 Electric Field Probe PEF-10 with Tripod TRI-10

5.4 LOOP ANTENNA MODEL ALP-10 (Figure 5.3)

5.4.1 DESCRIPTION. This unit is a highly sensitive, multiple-term, 25-inch loop antenna, designed for obtaining magnetic field measurements. Internal matching networks in the antenna base permit transfer of the received signal through a separate 50-ohm cable (CAC-10) to the Interference Analyzer BNC INPUT connector. The response of this instrument is proportional to signal frequency. The nomograph expressing this relationship with conversion to field strength or uV/meter will be found in Section VII.

5.4.2 INSTALLATION. For operation, mount on Tripod TRI-10 and connect to the BNC INPUT connector of the Interference Analyzer. Use the 25-foot multiple conductor cable (CAC-10).

5.4.3 OPERATION. No separate calibrations or adjustments are required on this antenna prior to operation.

5.4.4 MAINTENANCE. This unit is a self-contained, non-field-repairable item. Should there be any question of antenna malfunction, return to factory for repair or replacement.

Figure 5.3 Loop Antenna Model ALP-10

5.5 CLAMP-ON PROBE MODEL PCL-10 (Figure 5.4)

5.5.1 DESCRIPTION. This probe is used for the measurement of conducted currents where it is not possible to break the conducting cable. The probe, consisting of two hinged semicircles is capable of placement around conductors with diameters up to and including one inch.

5.5.2 INSTALLATION. First, clamp probe around cable to be measured and secure with thumbscrew provided. Then connect to BNC INPUT connector of Interference Analyzer using 25-foot coaxial cable CAC-10.

5.5.3 OPERATION. No special instructions are required with this unit.

5.5.4 MAINTENANCE. Periodically apply light oil sparingly to hinge points and lock screw. Do not let oil contaminate probe surfaces. No other maintenance is required. This unit is factory-sealed and non-field repairable. If unit malfunctions, return to factory for repair or replacement.

5.6 REMOTE METER MODEL RIM-10

5.6.1 DESCRIPTION. This meter is a duplicate of the front panel meter incorporated in the

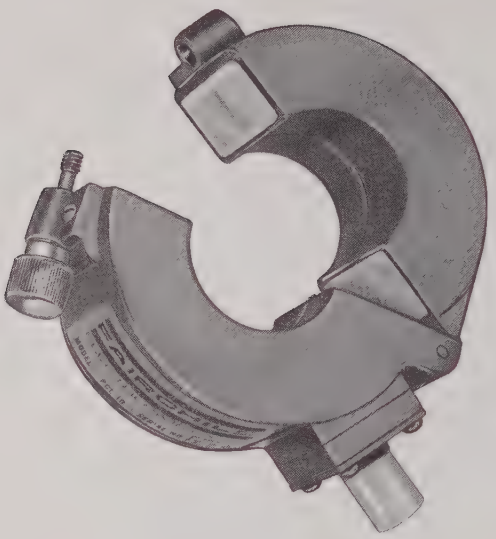


Figure 5.4 Clamp-on Probe Model PCL-10

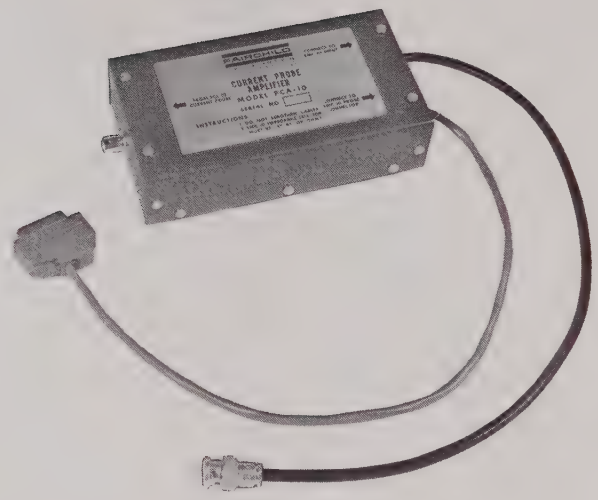


Figure 5.6 Current Probe Amplifier PCA-10

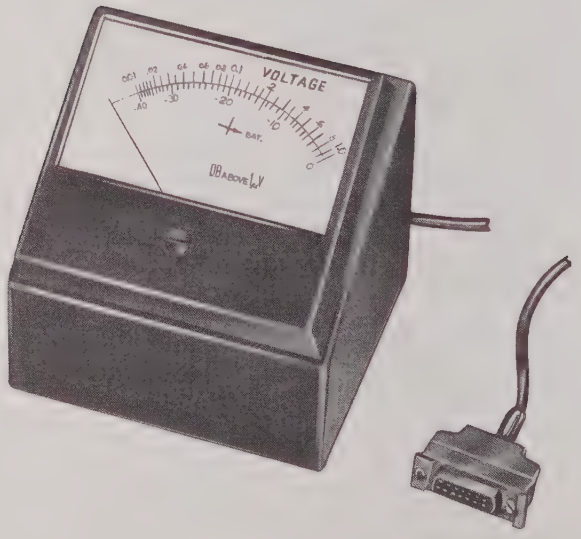


Figure 5.5 Remote Meter Model RIM-10

Interference Analyzer. It permits duplicate meter readings at a remote point.

5.6.2 INSTALLATION. To install the unit, first remove the dummy plug from the Interference Analyzer's remote connector. Connect meter using the 20-foot cable provided. A connector for this item is also available on the panel of the Electro-Scan Control Unit Model ESC-10.

5.6.3 OPERATION. Prior to taking measurements, check the position of the meter indicator while Interference Analyzer is turned off. Adjust the indicator mechanical adjustment screw located on the front panel (see Figure 5.5) until the meter reads zero. The meter will now duplicate the readings appearing on the Analyzer's front panel meter.

5.6.4 MAINTENANCE. This unit is shipped from the factory as a sealed item. The unit is non-field repairable, and, should any malfunction occur, it must be returned to the factory for repair or replacement.

5.7 CURRENT PROBE AMPLIFIER PCA-10 (Figure 5.6)

5.7.1 DESCRIPTION. The Current Probe Amplifier is used in conjunction with the Clamp-on Probe, Model PCL-10. Use of the Amplifier with the Clamp-on Probe allows current to be indicated directly on the EMC-10 meter; no conversion factors or charts are necessary. The Current Probe Amplifier receives power from the EMC-10 and has clearly marked input and output connectors.

5.7.2 INSTALLATION. Connect the Clamp-on Probe to the PCA-10 INPUT connector and the Amplifier to the EMC-10 INPUT connector and PROBE connector.

5.7.3 OPERATION. No special instructions are required with this unit.

5.7.4 MAINTENANCE. This unit is factory-sealed and is non-field repairable. If the unit malfunctions, return it to the factory for repair or replacement.

SECTION VI
REPLACEMENT PARTS

6.1 GENERAL

6.1.1 This section includes information which will be of assistance in the location and reordering of components. It covers electronic components, electronic assemblies, and replaceable mechanical parts.

6.2 ELECTRONIC COMPONENTS

6.2.1 The ordering part numbers of electronic components, indicated on the schematic diagrams, are formed by adding the component designation to the assembly number. For example, the part number of the resistor R12 of TVM assembly A4P4 would be A4P4 (R12). The part numbers of non-assembly components are listed in full on the schematic diagrams in Section VII.

6.2.2 Replaceable electronic components are those which form part of an accessible circuit. No attempt should be made to test or replace components in a sealed assembly. Sealed assemblies must be returned to the manufacturer for repair.

6.2.3 Printed circuit board components may be located by cross reference between the schematic diagrams and figure numbers shown in Table 6-1.

6.3 REPLACEABLE ELECTRONIC ASSEMBLIES

6.3.1 Replaceable electronic assemblies are those for which removal and replacement instructions are supplied in Section IV. The removal and repair of all other electronic assemblies must be performed by the manufacturer. The ordering part numbers of replaceable electronic assemblies are listed in Table 6-1.

6.4 REPLACEABLE MECHANICAL PARTS

6.4.1 Replaceable mechanical parts are limited to those which can be field-replaced without the need for special tools, jigs, etc. These parts are listed in Table 6-2.

TABLE 6-1
REPLACEABLE ELECTRONIC ASSEMBLIES

ITEM	REF	ASSEM.
Gear train	Figure 4.4	2251
Balanced modulator A2BM1	Figure 2.2	2179
Emitter follower A2EF1	Figure 2.2	2188
Audio filter A1FL1	Figure 4.5	2170
Gain potentiometer	Figure 2.2	A2R1
Dummy plug	Figure 3.1	2434
Circuit board A3P1	Figure 2.2	A3P1
Circuit board A3P2	Figure 2.2	A3P2
Circuit board A3P3	Figure 2.2	A3P3
Circuit board A3P4	Figure 2.2	A3P4
Circuit board A3P5	Figure 2.2	A3P5
Circuit board A3P6	Figure 2.2	A3P6
Circuit board A3P7	Figure 2.2	A3P7
Circuit board A3P8	Figure 2.2	A3P8
Circuit board A3P9	Figure 2.2	A3P9
Circuit board A4P4	Figure 2.2	A4P4
Circuit board A4P5	Figure 2.2	A4P5
Circuit board A4P6	Figure 2.2	A4P6
Circuit board A4P7	Figure 2.2	A4P7
Circuit board A5P5	Figure 4.1	A5P5

TABLE 6-2
REPLACEABLE MECHANICAL PARTS

ITEM	LOCATION	PART
Housing (case)		2031
Handle, carrying	Housing	2375
Cover, power supply	Rear, exterior	2068
Access cover	Subassembly A4	2141
Access cover, top	Subassembly A3	2181
Access cover, bottom	Subassembly A3	2182
Frequency control knob	Front panel	2054
AUDIO knob	Front panel	2062
LEVEL knob	Front panel	2063
ZERO knob	Front panel	2064
GAIN knob	Front panel	2425
BANDWIDTH knob	Front panel	2426
FILTER knob	Front panel	2426
IMPEDANCE knob	Front panel	2426
WIDE BAND knob	Front panel	2427
SELECTIVE knob	Front panel	2427
Detector function knob	Front panel	2428
Output function knob	Front panel	2428
△F knob	Front panel	2429

SECTION VII
REFERENCE DATA

7.1 GENERAL

7.1.1 This section contains calibration and measurement graphs and schematics essential to the operation of the instrument. The graphs have been printed on one side of the paper only. It is suggested that where the instrument is to be set up in a fairly permanent location, these measurement conversion graphs be removed from the book and posted where they may be easily read by the operator and receive the minimum amount of handling. However, should the graphs become illegible, additional copies may be obtained from the local representative for Fairchild EMC. The schematic diagrams for the instrument are presented in Figures 7.5 through 7.10

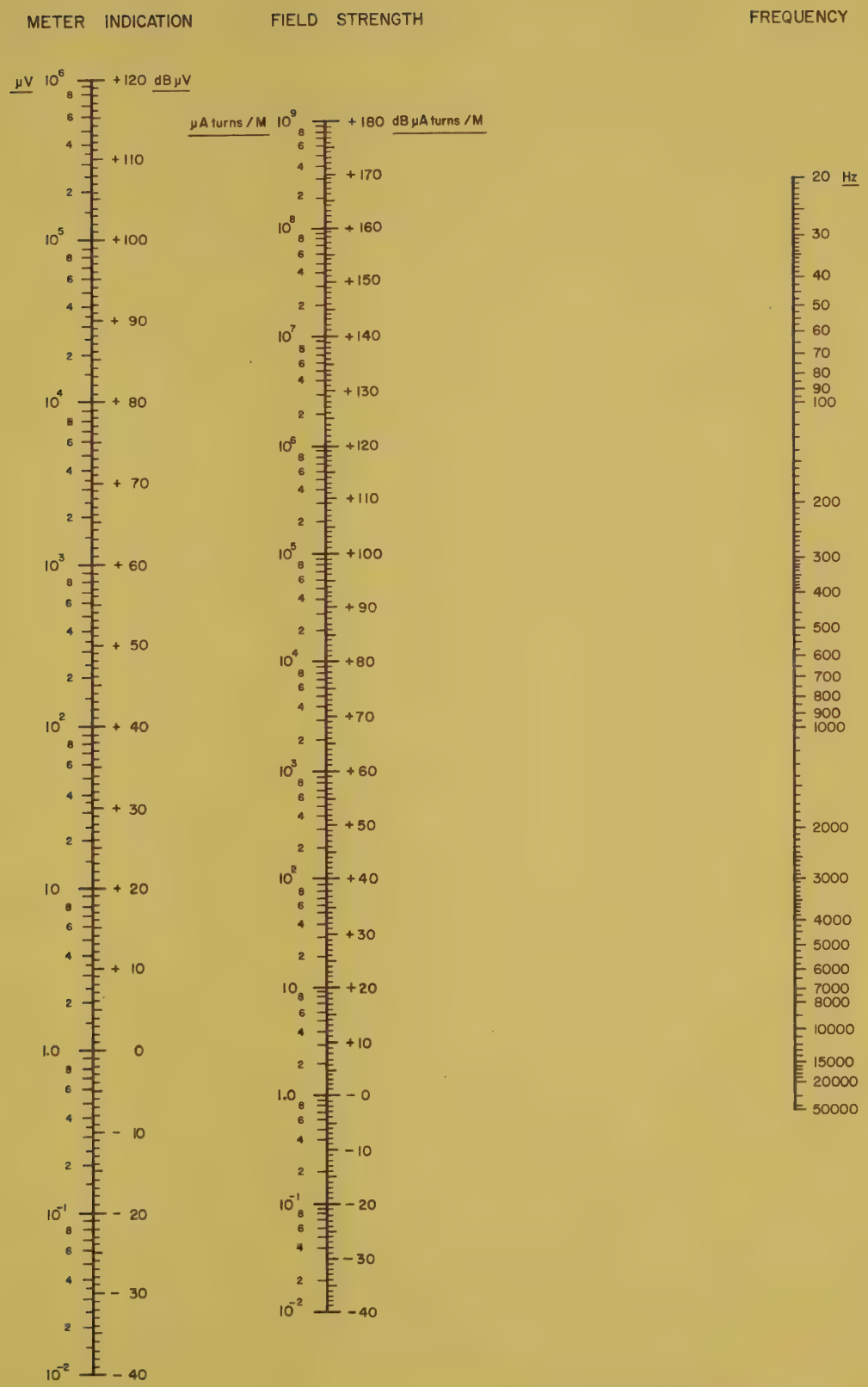


Figure 7.1 Loop Antenna Nomograph

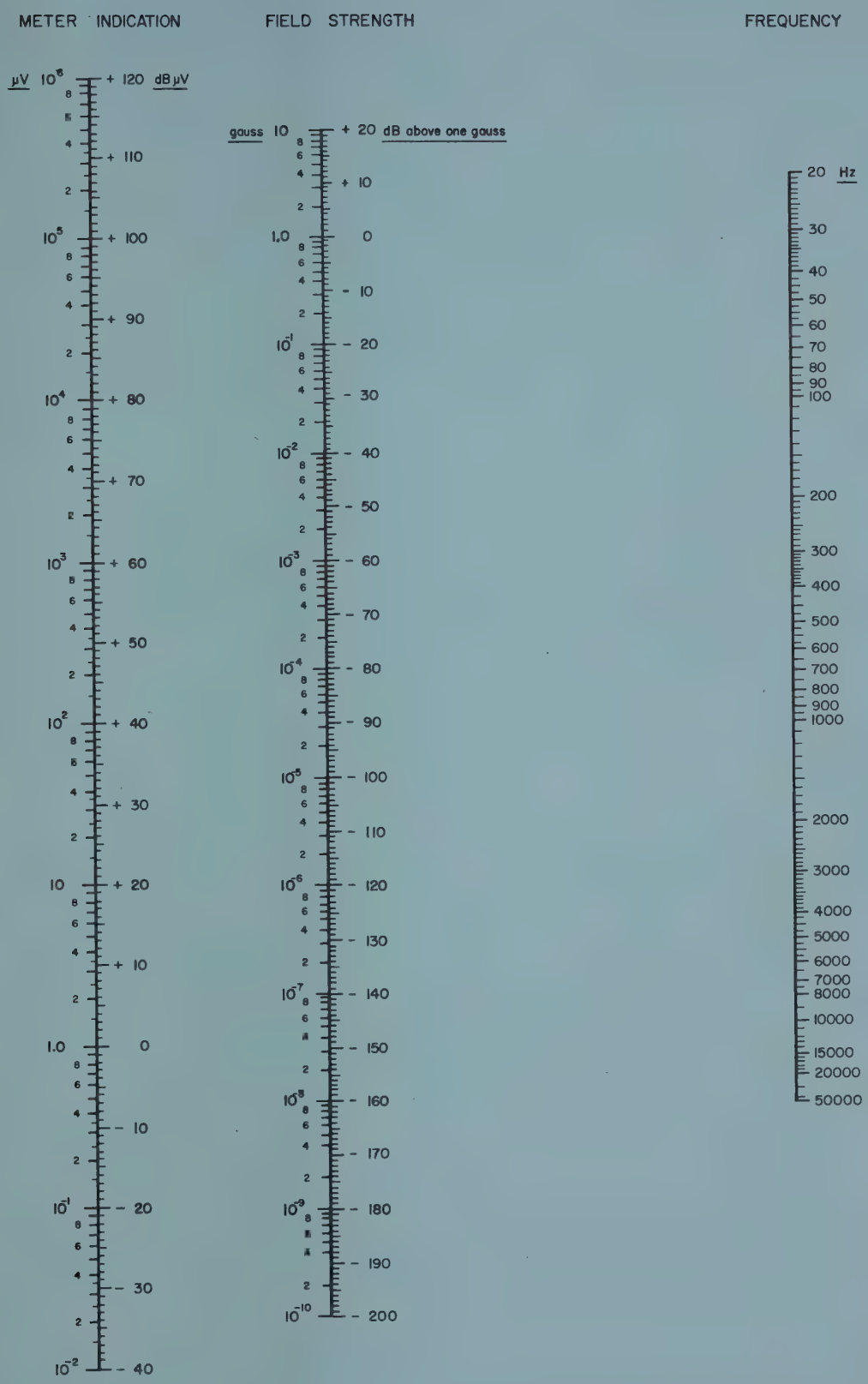


Figure 7.2 Loop Antenna Nomograph

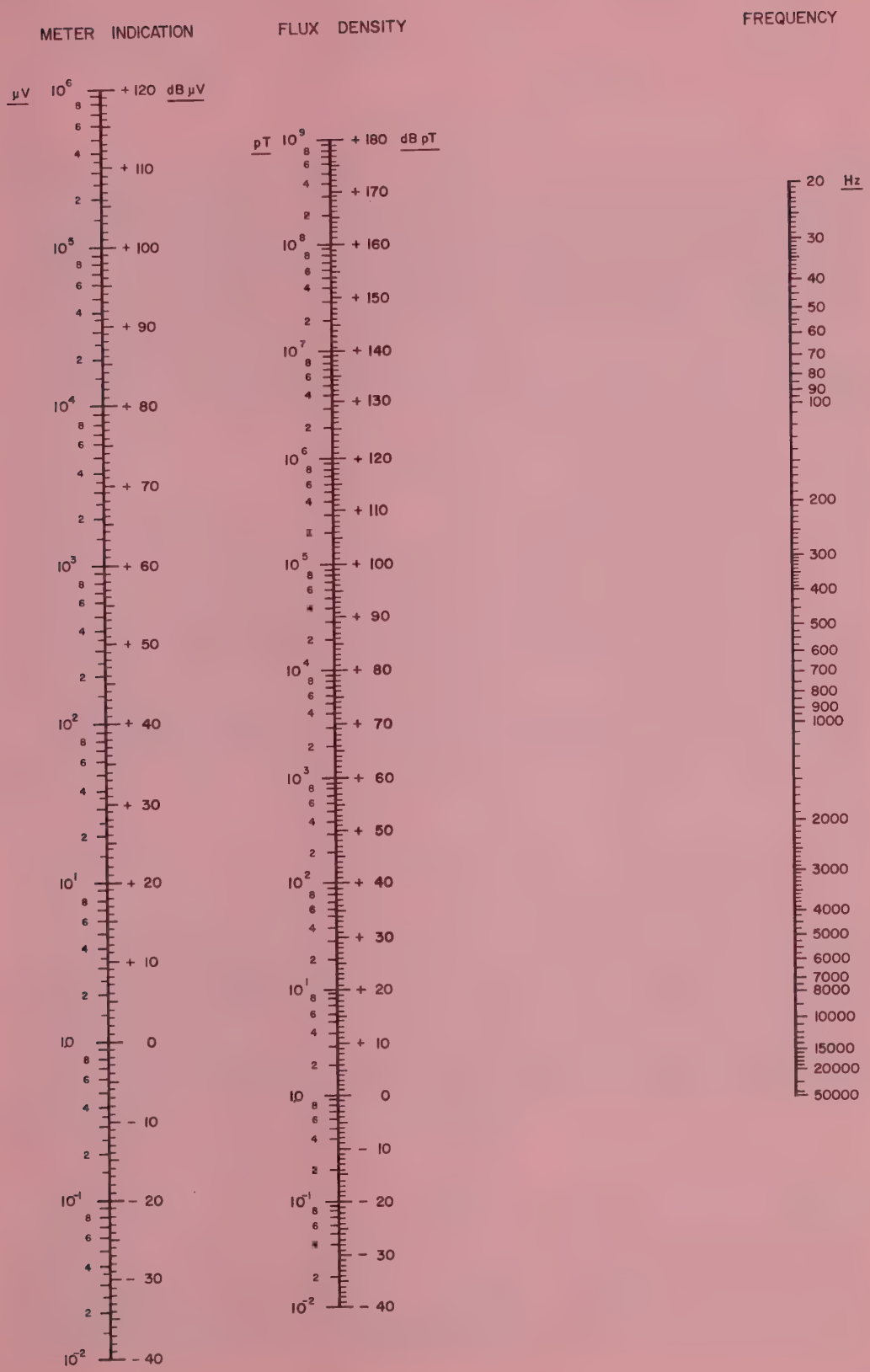


Figure 7.3 Loop Antenna Nomograph

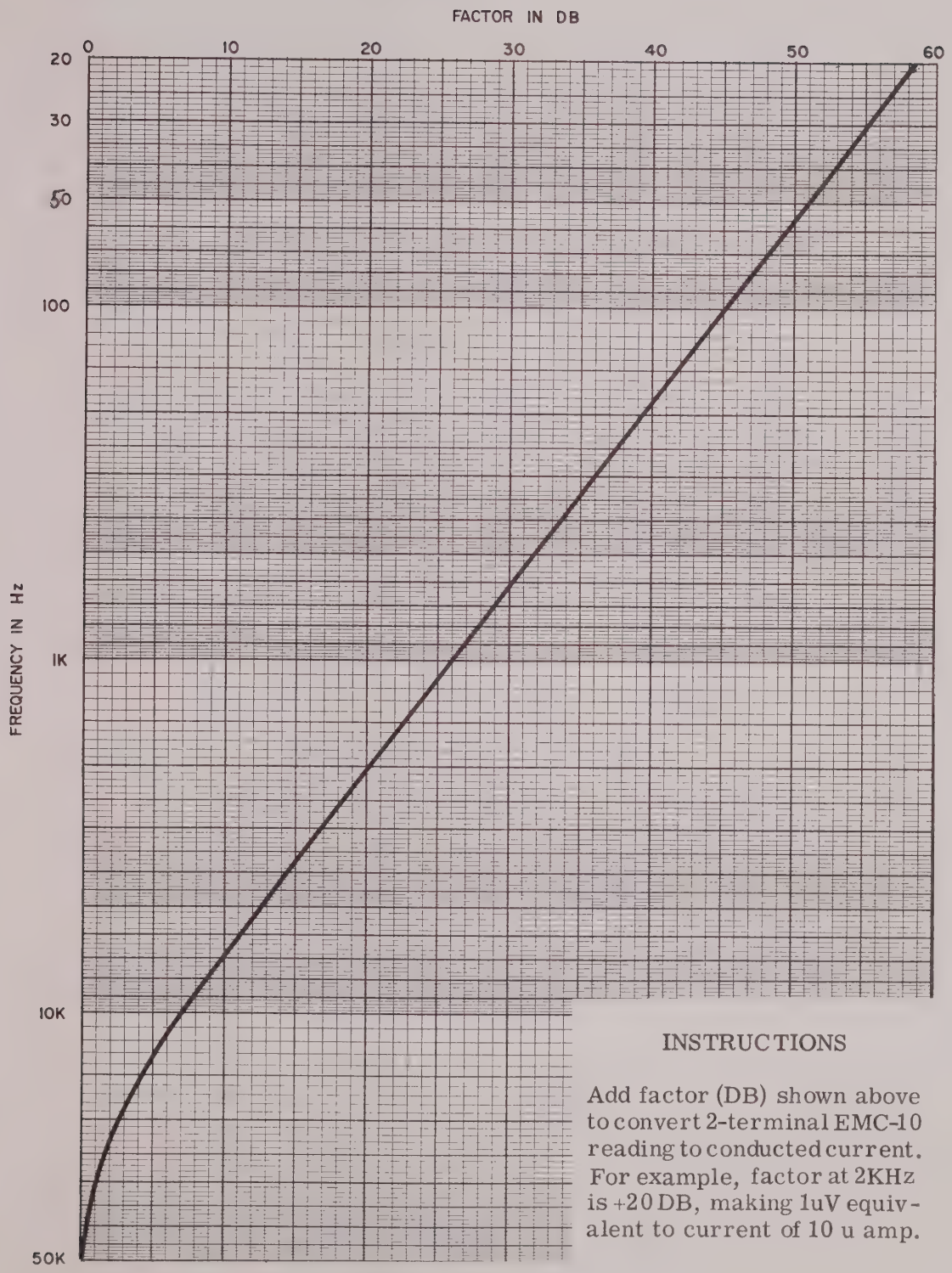
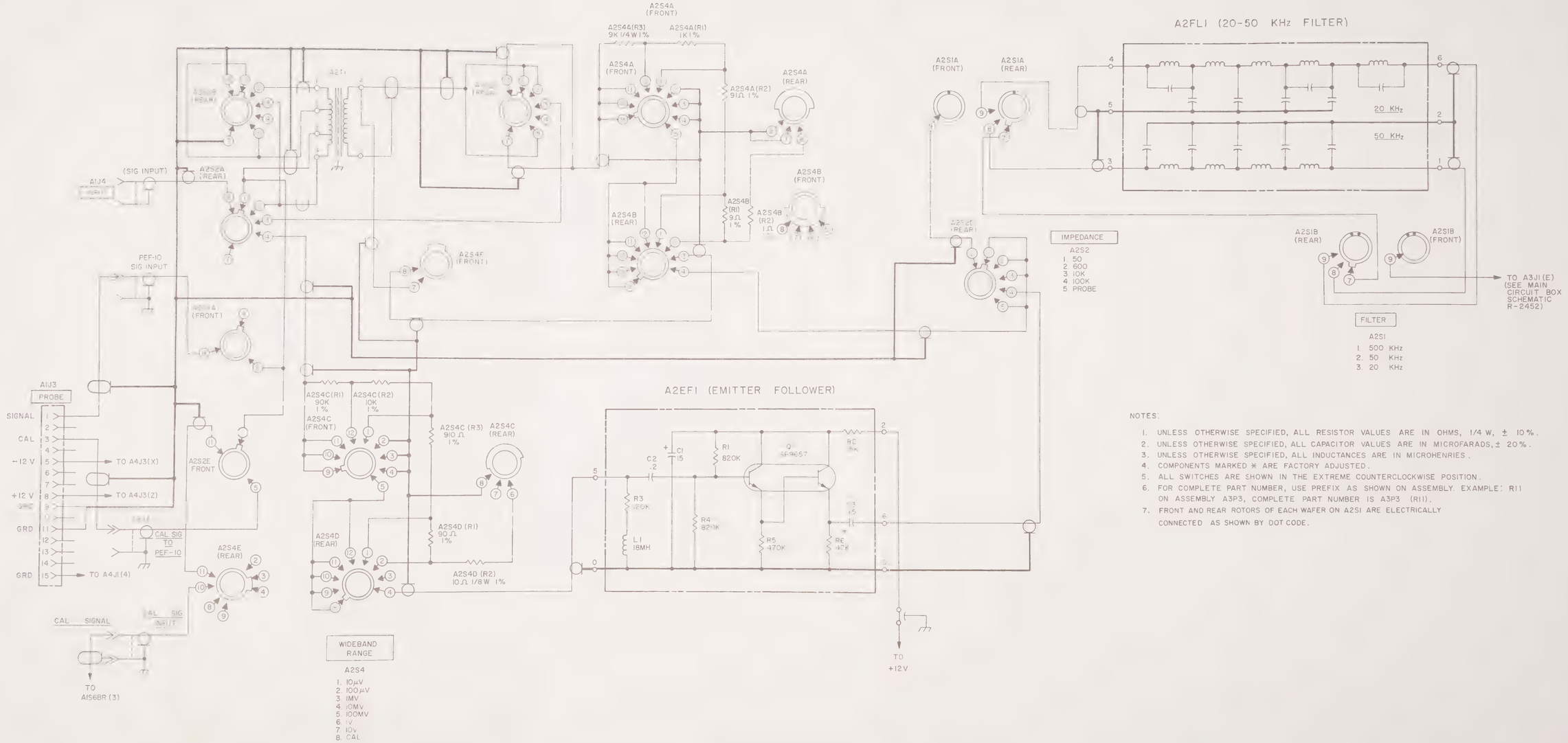


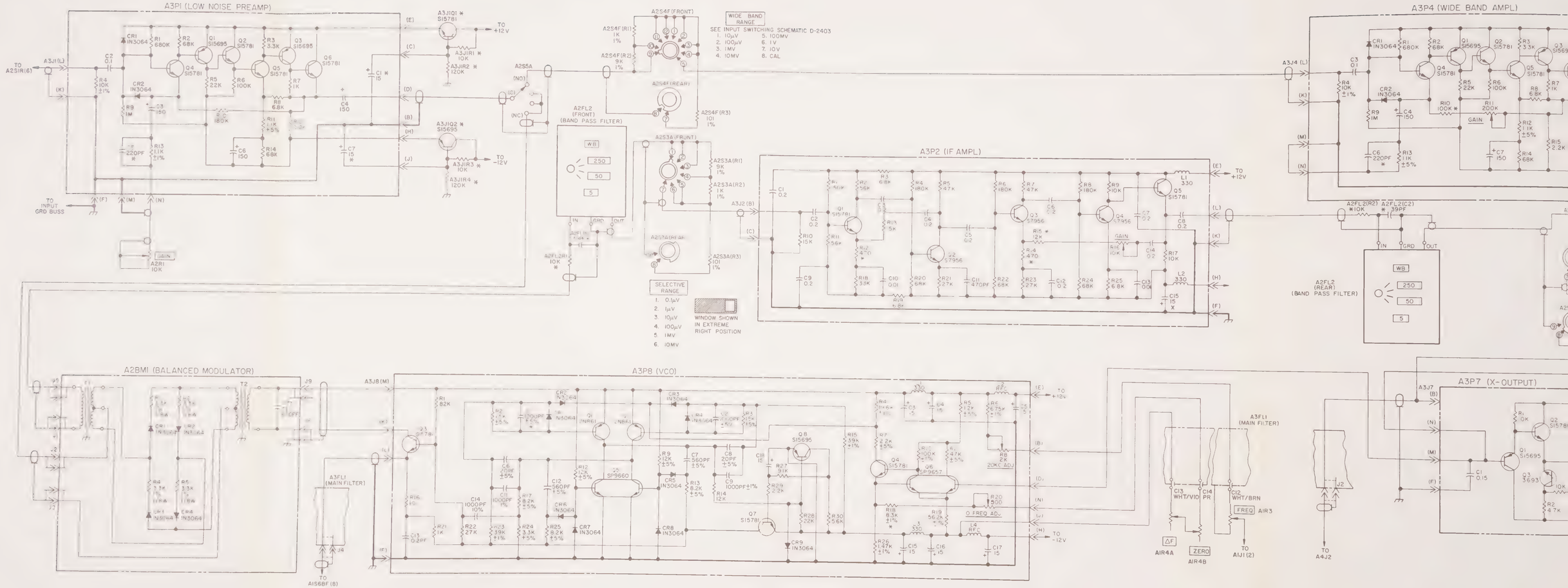
Figure 7.4 Clamp-On Probe Conversion Graph

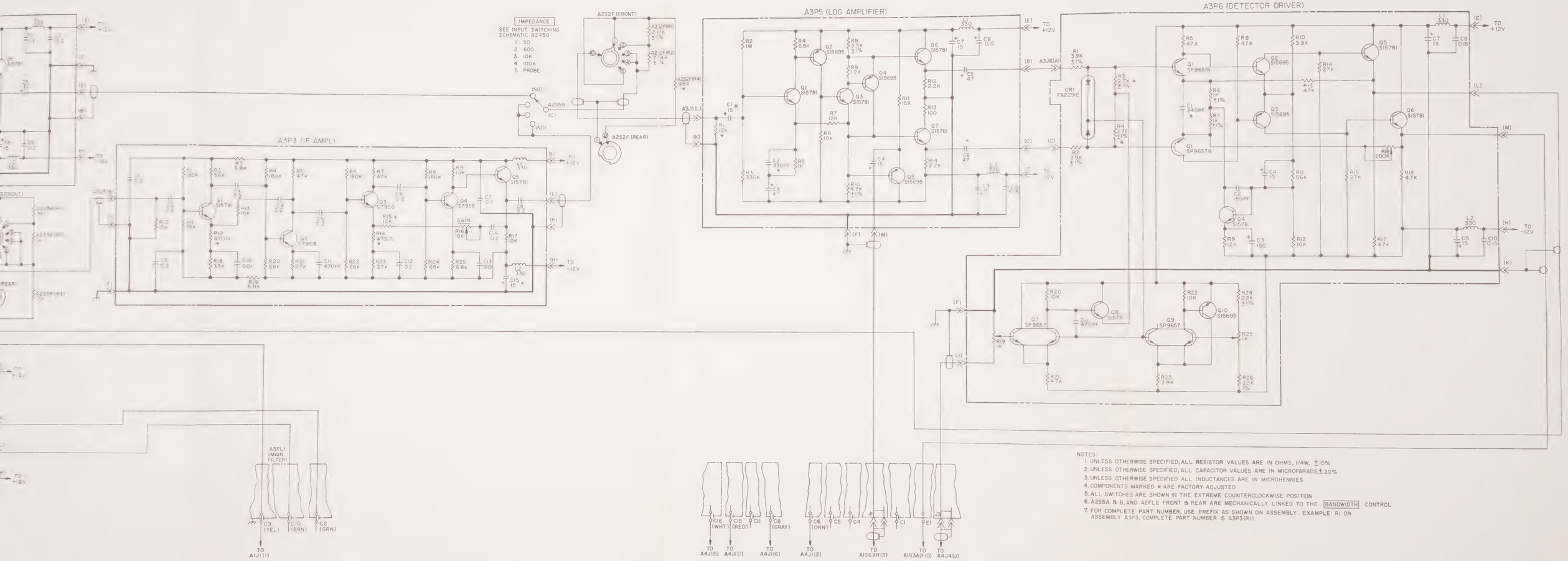


NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, 1/4 W, ± 10%.
2. UNLESS OTHERWISE SPECIFIED, ALL CAPACITOR VALUES ARE IN MICROFARADS, ± 20%.
3. UNLESS OTHERWISE SPECIFIED, ALL INDUCTANCES ARE IN MICROHENRIES.
4. COMPONENTS MARKED * ARE FACTORY ADJUSTED.
5. ALL SWITCHES ARE SHOWN IN THE EXTREME COUNTERCLOCKWISE POSITION.
6. FOR COMPLETE PART NUMBER, USE PREFIX AS SHOWN ON ASSEMBLY. EXAMPLE: R11 ON ASSEMBLY A3P3, COMPLETE PART NUMBER IS A3P3 (R11).
7. FRONT AND REAR ROTORS OF EACH WAFER ON A2S1 ARE ELECTRICALLY CONNECTED AS SHOWN BY DOT CODE.

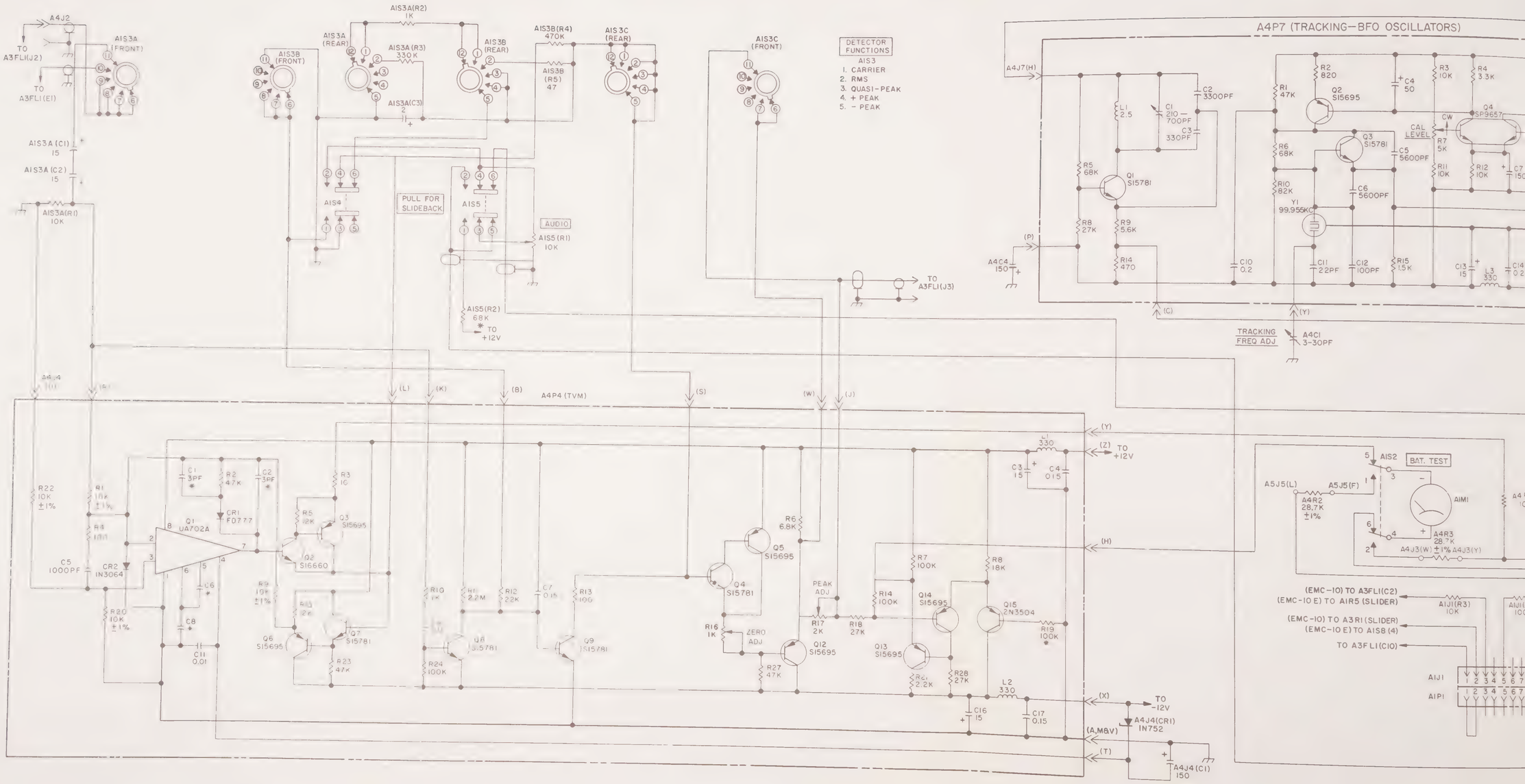
Figure 7.5 Input Switching

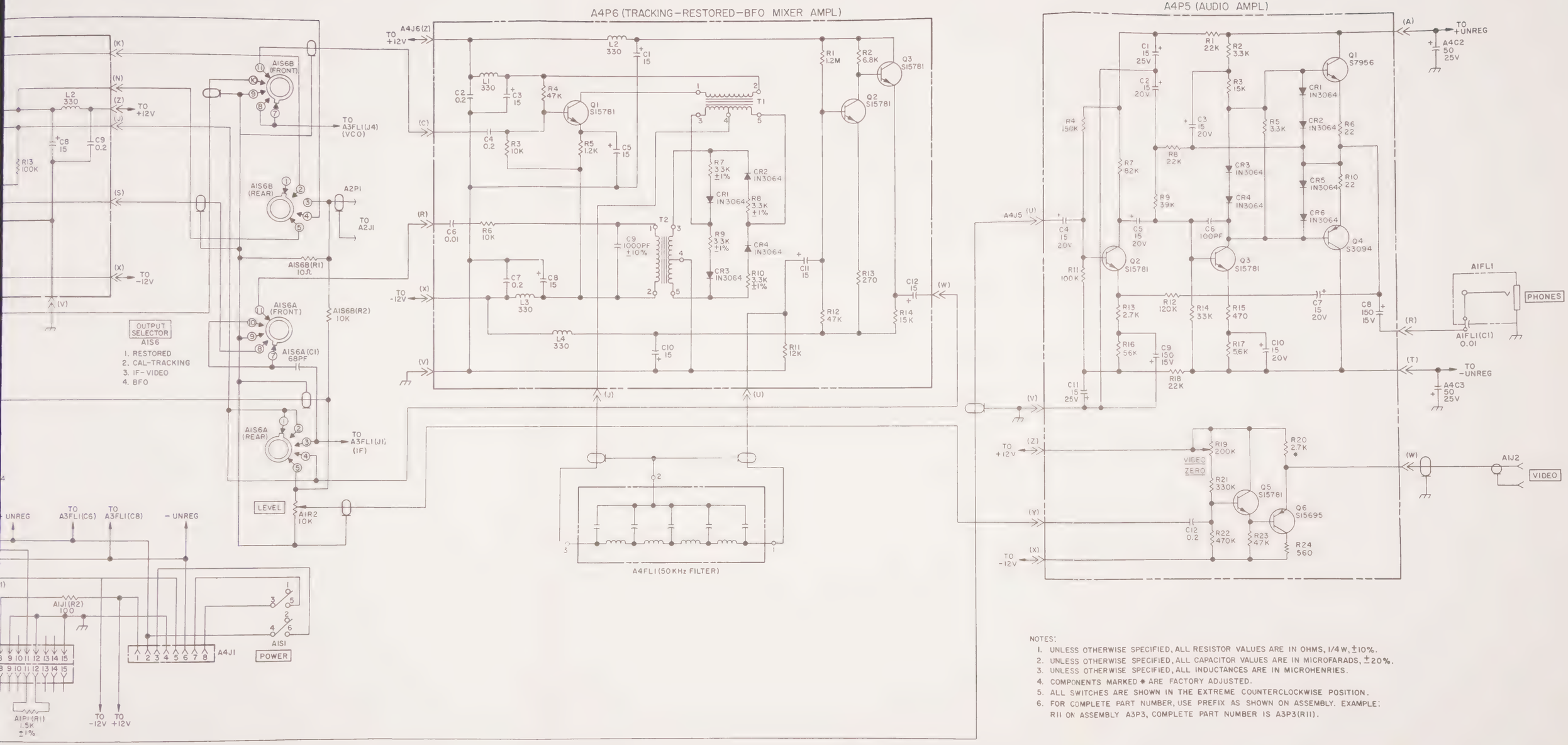

A3P1 (LOW NOISE PREAMP)
A3P4 (WIDE BAND AMPL)
A3P2 (IF AMPL)
A2BM1 (BALANCED MODULATOR)
A3P8 (VCO)
A3P7 (X-OUTPUT)
A3FL1 (MAIN FILTER)
A2FL2 (FRONT) (BAND PASS FILTER)
A2FL2 (REAR) (BAND PASS FILTER)
A2S4F(FRONT)
A2S4F(REAR)
A2S3A(FRONT)
A2S3A(REAR)
A2S5A
WIDE BAND RANGE
SEE INPUT SWITCHING SCHEMATIC D-2403
1. 10μV 5. 100MV
2. 100μV 6. 1V
3. 1MV 7. 10V
4. 10MV 8. CAL
SELECTIVE RANGE
1. 0.1μV
2. 1μV
3. 10μV
4. 100μV
5. 1MV
6. 10MV
WINDOW SHOWN IN EXTREME RIGHT POSITION
TO +12V
TO -12V
TO INPUT GRD BUSS
TO A2S1R(6)
TO A156BF(8)
TO A4J2
GAIN
FREQ ADJ
ZERO ADJ
AIR3
AIR4A
AIR4B



NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, 1/4W, ±10%
2. UNLESS OTHERWISE SPECIFIED, ALL CAPACITOR VALUES ARE IN MICROFARADS, ± 20%
3. UNLESS OTHERWISE SPECIFIED ALL INDUCTANCES ARE IN MICROHENRIES
4. COMPONENTS MARKED * ARE FACTORY ADJUSTED
5. ALL SWITCHES ARE SHOWN IN THE EXTREME COUNTERCLOCKWISE POSITION
6. A255A & B, AND A2FL2 FRONT & REAR ARE MECHANICALLY LINKED TO THE BANDWIDTH CONTROL
7. FOR COMPLETE PART NUMBER, USE PREFIX AS SHOWN ON ASSEMBLY. EXAMPLE: R1 ON ASSEMBLY A1P3, COMPLETE PART NUMBER IS A3P3(R1)

Figure 7.6 Main Circuit Box


A4J2
TO A3FLI(J2)
TO A3FLI(E1)
AIS3A (FRONT)
AIS3A (REAR)
AIS3A(R2) 1K
AIS3A(R3) 330K
AIS3A(C3) 2
AIS3B (FRONT)
AIS3B (REAR)
AIS3B(R4) 470K
AIS3B (R5) 47
AIS3C (REAR)
AIS3C (FRONT)
DETECTOR FUNCTIONS
AIS3
1. CARRIER
2. RMS
3. QUASI-PEAK
4. + PEAK
5. - PEAK
AIS3A (C1) 15
AIS3A (C2) 15
AIS3A(R1) 10K
AIS4
PULL FOR SLIDEBACK
AIS5
AUDIO
AIS5(R1) 10K
AIS5(R2) 68K
TO +12V
TO A3FLI(J3)
A4P7 (TRACKING—BFO OSCILLATORS)
A4J7(H)
L1 2.5
C1 210—700PF
C2 3300PF
C3 330PF
R1 47K
R2 820
Q2 S15695
C4 50
R3 10K
R4 3.3K
Q4 SP9657
CW
CAL LEVEL
R7 5K
R5 68K
Q1 S15781
Q3 S15781
C5 5600PF
R6 68K
R10 82K
Y1 99.955KC
C6 5600PF
R11 10K
R12 10K
C7 15
R8 27K
R9 5.6K
R14 470
C10 0.2
C11 22PF
C12 100PF
R15 1.5K
C13 15
L3 330
C14 0.2
(P)
A4C4 150
(C)
(Y)
TRACKING FREQ ADJ
A4C1 3-30PF
A4J4 (101)
(L)
(K)
(B)
A4P4 (TVM)
(S)
(W)
(J)
R22 10K ±1%
R1 10K ±1%
R4 100
C1 3PF
R2 47K
C2 3PF
R3 10
CR1 FD777
Q1 UA702A
R5 12K
Q3 S15695
Q2 S16660
C5 1000PF
CR2 IN3064
R20 10K ±1%
C6
C8
C11 0.01
R9 10K ±1%
R21 22
Q6 S15695
Q7 S15781
R23 47K
R10 1K
R11 2.2M
R12 22K
C7 0.15
R13 100
Q8 S15781
R24 100K
Q9 S15781
R6 6.8K
Q5 S15695
Q4 S15781
R16 1K
ZERO ADJ
Q12 S15695
R27 47K
PEAK ADJ
R17 2K
R18 27K
R7 100K
R14 100K
Q13 S15695
R24 2.2K
R8 18K
Q14 S15695
Q15 2N3504
R19 100K
R28 27K
L2 330
C16 15
C17 0.15
L1 330
C3 15
C4 015
(Y)
(Z) TO +12V
(H)
(X)
TO -12V
A4J4(CR1) IN752
(A,M&V)
(T)
A4J4(C1) 150
A5J5(L)
A5J5(F)
AIS2
BAT. TEST
AIM1
A4R2 28.7K ±1%
A4R3 28.7K ±1%
A4J3(W) ±1% A4J3(Y)
(EMC-10) TO A3FLI(C2)
(EMC-10 E) TO AIR5 (SLIDER)
AIJI(R3) 10K
(EMC-10) TO A3RI (SLIDER)
(EMC-10 E) TO AIS8 (4)
TO A3FLI(C10)
AIJ1
AIP1
1 2 3 4 5 6 7



NOTES:

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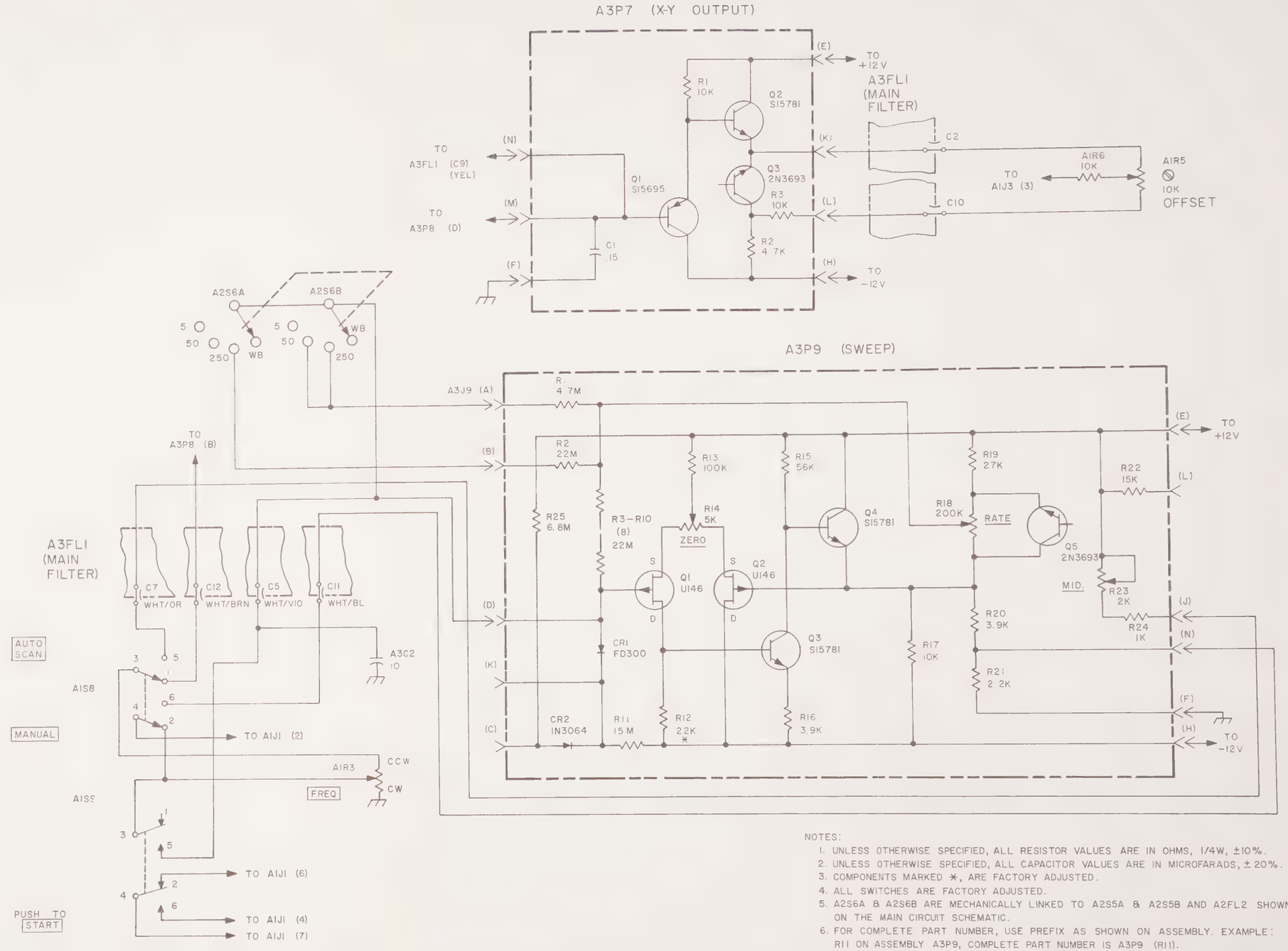
2. UNLESS OTHERWISE SPECIFIED, ALL CAPACITOR VALUES ARE IN MICROFARADS, ±20%.
3. UNLESS OTHERWISE SPECIFIED, ALL INDUCTANCES ARE IN MICROHENRIES.
4. COMPONENTS MARKED * ARE FACTORY ADJUSTED.
5. ALL SWITCHES ARE SHOWN IN THE EXTREME COUNTERCLOCKWISE POSITION.
6. FOR COMPLETE PART NUMBER, USE PREFIX AS SHOWN ON ASSEMBLY. EXAMPLE: R11 ON ASSEMBLY A3P3, COMPLETE PART NUMBER IS A3P3(R11).

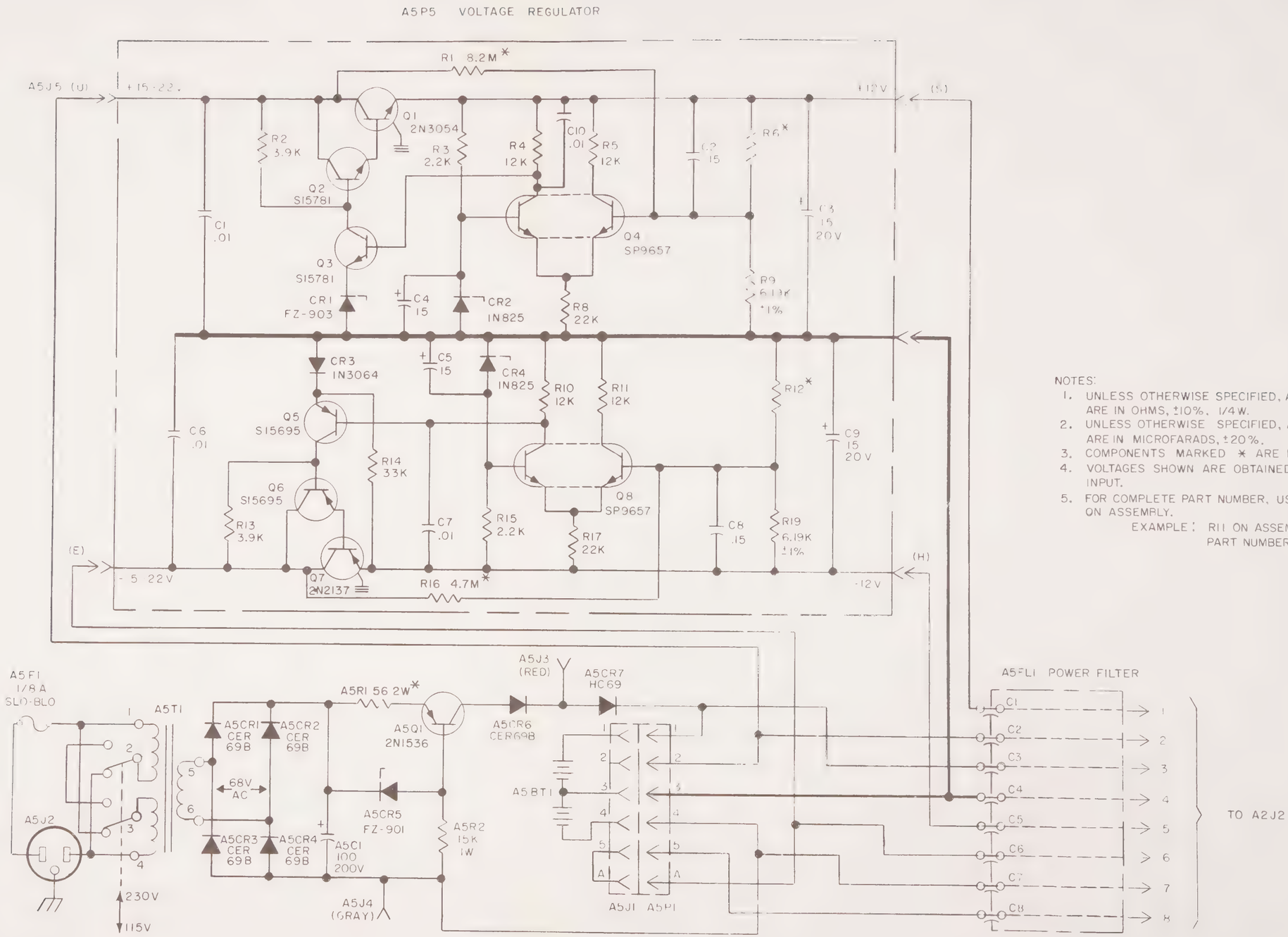
Figure 7.7 Meter Circuit



NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, 1/4W, ±10%.
2. UNLESS OTHERWISE SPECIFIED, ALL CAPACITOR VALUES ARE IN MICROFARADS, ± 20%.
3. COMPONENTS MARKED *, ARE FACTORY ADJUSTED.
4. ALL SWITCHES ARE FACTORY ADJUSTED.
5. A2S6A & A2S6B ARE MECHANICALLY LINKED TO A2S5A & A2S5B AND A2FL2 SHOWN ON THE MAIN CIRCUIT SCHEMATIC.
6. FOR COMPLETE PART NUMBER, USE PREFIX AS SHOWN ON ASSEMBLY. EXAMPLE: R11 ON ASSEMBLY A3P9, COMPLETE PART NUMBER IS A3P9 (R11).

Figure 7.8 Sweep Circuit



NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, ±10%, 1/4W.
2. UNLESS OTHERWISE SPECIFIED, ALL CAPACITOR VALUES ARE IN MICROFARADS, ±20%.
3. COMPONENTS MARKED * ARE FACTORY ADJUSTED.
4. VOLTAGES SHOWN ARE OBTAINED WITH 117V, 60Hz INPUT.
5. FOR COMPLETE PART NUMBER, USE PREFIX AS SHOWN ON ASSEMBLY.
   EXAMPLE: R11 ON ASSEMBLY A3P3, COMPLETE PART NUMBER IS A3P3(R11).

Figure 7.9 Power Supply

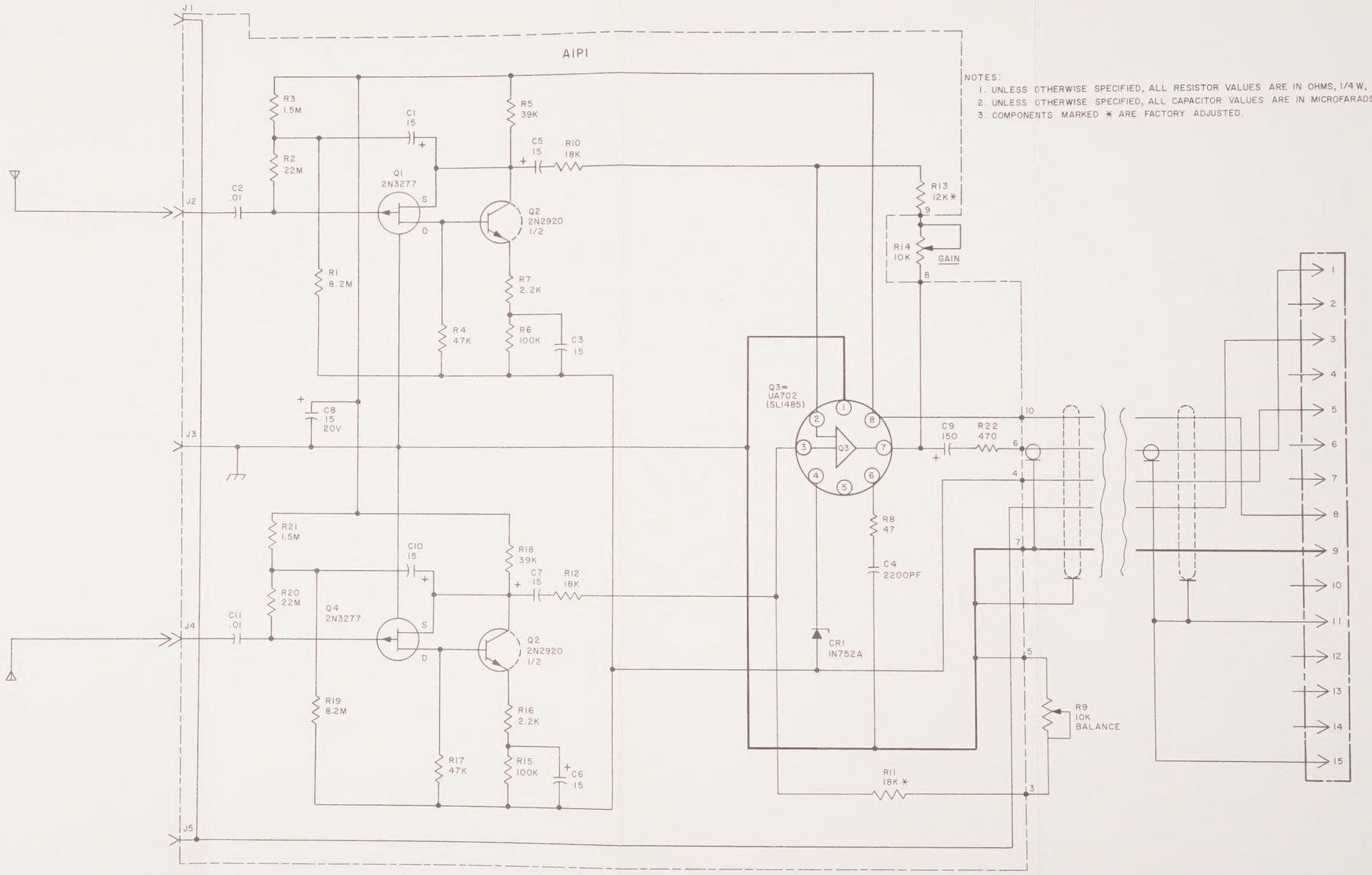


Figure 7.10 PEF-10

Warranty

Electro-Metrics Corporation warrants that the articles delivered under each purchase order or contract will be free from defects in material or workmanship, under normal use and service, for a period of one year from the date of delivery to the Buyer. Electro-Metrics' obligations under this paragraph are limited, at its option, to repairing or replacing with reasonable promptness, such articles which are returned to Electro-Metrics' factory at Amsterdam, New York, transportation charges prepaid, and which, after examination are disclosed to Electro-Metrics' satisfaction to be thus defective. Semiconductors, electron tubes, fuses and batteries are excluded from liability. The provisions of this paragraph are effective only if a claim is made in writing to Electro-Metrics with the relevant information with respect to the alleged defect, within thirty (30) days following discovery of said defect.

The foregoing provisions of this warranty shall be effective only if the articles delivered under this purchase order or contract have been maintained, repaired, handled, utilized and stored in accordance with Electro-Metrics written instructions relating thereto and have not been subjected to misuse, improper installation, negligence, or accident. The provisions of this Warranty Clause are in lieu of all other warranties, expressed or implied, and of all other obligations or liabilities on Electro-Metrics' part and it neither assumes nor authorizes any other person to assume for Electro-Metrics any other liabilities in connection with the sale of the said articles. In no event shall Electro-Metrics be liable for any consequential or special damages.

Vice President, General Mgr.

FAIRCHILD
ELECTRO-METRICS
CORPORATION
[illegible] ST., AMSTERDAM, NEW YORK 12010

Buyer_____

P.O._____

Date_____

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